AD-A141 292 MK 16 DEPLOYMENT PROCEDURES(U) NAVY EXPERIMENTAL DIVING 1/1
UNIT PANAMA CITY FL K W WRIGHT JUL 83 NEDU-10-83

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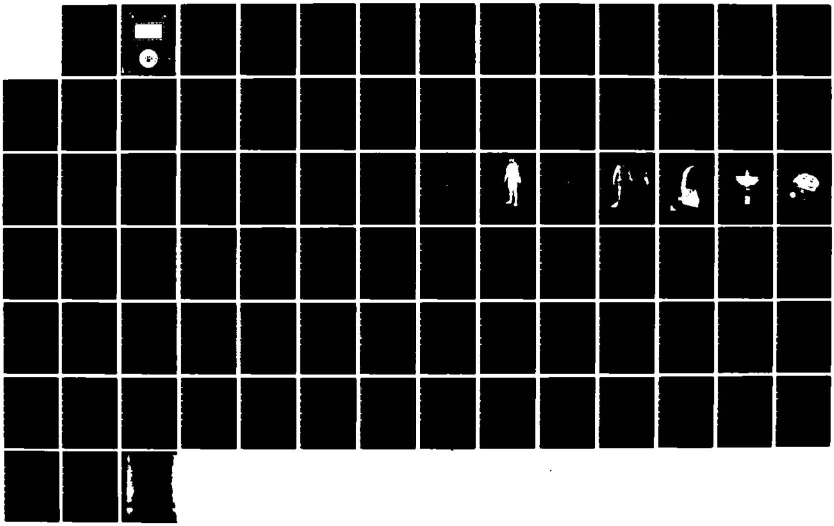

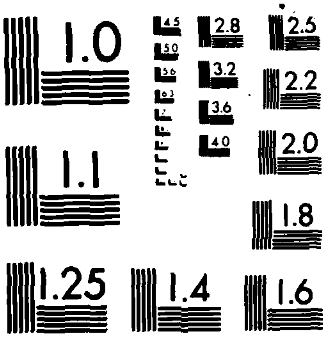

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DEPARTMENT OF THE NAVY
NAVY EXPERIMENTAL DIVING UNIT
PANAMA CITY, FLORIDA 32407

IN REPLY REFER TO:

NAVY EXPERIMENTAL DIVING UNIT

REPORT NO. 10-83

MK 16 DEPLOYMENT PROCEDURES

KEVIN W. WRIGHT

JULY 1983

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NEDU REPORT NO. 10-83	2. GOVT ACCESSION NO. AD A141212	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) MK 16 DEPLOYMENT PROCEDURES		5. TYPE OF REPORT & PERIOD COVERED TEST REPORT
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) KEVIN W. WRIGHT		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS NAVY EXPERIMENTAL DIVING UNIT PANAMA CITY, FL 32407		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE JULY 1983
		13. NUMBER OF PAGES 83
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DEPLOYMENT PROCEDURES
MIXED GAS SCUBA
MK 16 MOD 0 UBA

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Navy Experimental Diving Unit conducted manned open water testing to evaluate deployment procedures for mixed gas self contained underwater breathing apparatus (SCUBA: MK 16 MOD 0 UBA) in June 1983. In water decompression was conducted day and night in ambient water temperature ranges of 58 to 70°F.

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The new procedures proved fully compatible with in-service U.S. Navy equipment. In addition, the procedures were used to deploy self contained divers to 205 FSW for a bottom time of 25 minutes and safely perform requisite decompression in water using minimal surface support.

Table of Contents

Glossary

ATA	atmosphere
BC	buoyancy compensator
BLJ	buoyancy life jacket
CO_2	carbon dioxide
cu/ft	cubic/foot (feet)
DC	decompression
DCS	decompression sickness
DDC	deck decompression chamber
DMO	Diving Medical Officer
EOD	Explosive Ordnance Disposal
FSW	feet of seawater
ft	feet
He	helium
HeO_2	helium oxygen
HP	high pressure
hp	horse power
IAW	in accordance with
MCM	mine counter measures
MGS	mixed gas SCUBA
min	minutes
NEDU	Navy Experimental Diving Unit
N_2O_2	nitrogen oxygen
NK	not known
NOD	no decompression

Glossary (cont'd)

O_2	oxygen
PPO_2	partial pressure of oxygen
psig	pounds per square inch gauge
RCC	recompression chamber
SCUBA	self contained underwater breathing apparatus
TT	treatment table
USD	U.S. Divers Company
USN	United States Navy

Abstract

The Navy Experimental Diving Unit conducted manned open water testing to evaluate deployment procedures for mixed gas self contained underwater breathing apparatus (SCUBA: MK 16 MOD 0 UBA) in June 1983. In water decompression was conducted day and night in ambient water temperature ranges of 58 to 70°F.

The new procedures proved fully compatible with in-service U.S. Navy equipment. In addition, the procedures were used to deploy self contained divers to 205 FSW for a bottom time of 25 minutes and safely perform requisite decompression in water using minimal surface support.

KEY WORDS: Deployment Procedures
Mixed Gas SCUBA
MK 16 MOD 0 UBA

I. INTRODUCTION

In June 1983, new deployment procedures for mixed gas SCUBA were evaluated by the Navy Experimental Diving Unit. Testing and evaluation was accomplished under the auspices of NAVSEA Task Number 83-06 and in accordance with reference 1 to determine the suitability of the procedures for use with the U.S. Navy MK 16 MOD 0 UBA. The MK 16 will greatly increase the depth capability of the self contained diver in the Explosive Ordnance Disposal (EOD) and Mine Counter Measures (MCM) environment. Incumbent with a mission depth increase is the requirement for accurate, controlled decompression for prolonged time periods. When considering the most satisfactory method of diver decompression in an EOD/MCM scenario, a primary constraint is to maintain flexibility of response, a major factor in this type of operation.

Two primary techniques are presently available to decompress a deployed diver:

a. Surface Decompression. Using this method a surface recompression chamber is employed. The diver is brought to the surface prior to fulfilling decompression requirements and is then recompressed in the surface chamber after the shortest possible surface interval. Decompression is then completed in the surface chamber. Normally specific surface decompression tables are used.

b. In Water Decompression. The diver remains in water throughout the dive profile performing all requisite decompression prior to surfacing.

Selection of surface decompression methods would have the following implications:

a. Increased support personnel requirement.

b. Proportionate increase in equipment support.

c. The need for the development of safe surface decompression tables.

d. A surface vessel of adequate size to carry recompression facilities will be required for all operations in excess of 80 FSW.

It is apparent, therefore, to fully utilize the MK 16 and to minimize the impact of decompression upon mission accomplishment in normal operations, a safe and controlled method of in-water decompression is desirable, if not essential.

In the United Kingdom, the Royal Navy uses in-water decompression for the majority of diving operations, both surface supplied and self contained. Of specific interest, six man teams have the capability to deploy closed circuit mixed gas diving equipment to a depth of 180 FSW from an inflatable craft. Decompression is performed in water. The system is deployed in search, survey, EOD and MCM operations. These proven techniques form the basis of the new deployment techniques evaluated by the Navy Experimental Diving Unit (NEDU). The objectives of this test series were:

a. Test and evaluate the new procedures in an open water environment to 200 feet of seawater (FSW) both day and night.

b. Safely deploy and recover a single diver to a maximum depth of 200 FSW for prolonged bottom time.

c. Establish operating parameters for the new procedures.

d. Identify any special procedural requirements for the MK 16 in the environment detailed above.

e. Validate 0.7 atmosphere (ATA) constant partial pressure of oxygen (PO_2) in helium decompression tables in an open water environment.

II. PROCEDURE DESCRIPTION

As stated above, these procedures were broadly based upon techniques already in use by the Royal Navy and detailed in reference 2. A major difference, however, was the addition of an emergency breathing system (EBS) providing an alternative breathing source to a diver already committed to in-water decompression in the event of a major rig malfunction.

Simply described, the procedures are designed to operate with two categories of diving operation. The first, identified as 'marked swimming' or 'marked swimming in pairs', allows divers to be employed in large area searches using grid or compass techniques. Except for a light line and marker float this type of operation is free swimming, requiring only a small surface craft to maneuver to the float at the end of the dive to conduct surface controlled decompression. The second, 'attended swimming', requires a diver or pair of divers to be tended throughout the diving operation and is intended for deeper water with short radius searches. The procedures are designed to be used by a minimum of four personnel (including the diver) from an inflatable craft of the Zodiac or USN MK I Swimmer Support Craft type. The surface support requirements are, therefore, projected to be minimal. Details of equipment and procedures are shown in APPENDIX A. In precis, all dives whether single diver or divers in pairs, will be tethered by means of a light, depth marked line either secured to a marker float or kept in hand by a tender. Decompression incurred during a dive profile will be controlled by the Diving Supervisor in a surface craft. Accurate control of diver depth is achieved by use of a weight (called a Lazy Shot), also secured to a depth marked line, which is lowered via the diver marker line or a descent line to the deepest decompression stop. During ascent, divers remain at the weight performing requisite decompression time at each stop as controlled by the raising of the weight by the surface crew. A crucial factor in the procedures and proposed deployment is that of recompression facility availability, a subject which is discussed in detail in Section IV, paragraph E.5. below.

III. TEST PROCEDURE

Testing was conducted in accordance with reference 1. During training and evaluation, a total of 159 man dives were made in water depths of 40 to 205 FSW, day and night. Specific dive and environmental details are shown in APPENDIX B. It is considered that training dives are within the scope of this report due to the intensive procedural indoctrination that took place during

this period. The overall test scenario was of area search operations and short radius 'spot' diving. Divers were deployed both in pairs and singly during marked swimming operations for bottom times up to 60 minutes. For attended swimming, paired and single divers were used for a series of bottom times between 10-30 minutes with a surface support crew of three (supervisor, standby and attendant). A safety boat was available at all times with a crew of two and a spare MK 15 UBA in the event of emergency.

Average surface air temperatures ranged from 80 to 90°F. Ambient water temperatures were recorded as 70°F at 60 FSW and 59°F at 205 FSW. Diver-Subjects used wet suits throughout evaluation. Operations were conducted in sea conditions to State 4. Maximum tidal current experienced was 1.5 knots.

IV. RESULTS AND DISCUSSION

In almost all aspects the procedures were judged to be successful. Due to the diverse nature of each component of the operation, they are discussed individually below.

A. Equipment

1. UBA. Due to non availability of MK 16 MOD 0 UBA, the MK 15 UBA was used throughout. Of 12 rigs available, six were fitted with the Navy type harness (including jockstrap) the remainder being of the Army type configuration. (Aside from the absence of a jockstrap, the Army harness is the same as that proposed for the MK 16.)

The Army rigs, fitted with a simple waist strap and shoulder harness, proved considerably easier to don and doff than those rigs fitted with the Navy type harness. This was due to the fact that the hook securing system of the Navy five point harness is located at the sternum of the average diver. If wearing a life jacket, it is virtually impossible to secure the harness beneath it. Alternatively, if secured over the lifejacket, the harness impedes correct inflation.

A major problem encountered with the Army harnesses was the fragile nature of the hinged side panels. If not laid flush to the back of the rig, knocks against the panels causes them to break away from the rig casing. In a small boat environment, this proved to be a considerable disadvantage.

2. Diving Boats. The inflatable craft is an already well proven dive platform and used in almost all Navies deploying EOD divers. It is not, therefore, intended to document the design advantages of this type of craft in this report. Inflatables in use during testing were:

a. Eighteen foot Zodiac, inflatable keel, aluminum deck Model GR 3463.

b. Eighteen foot USN MK I Swimmer Support Craft, wooden rigid keel, wooden deck.

A Marine Amphibious Reconnaissance System (MARS) craft was loaned by the Naval Coastal Systems Center with the intention of use during testing, however its design characteristics as a rapid deployment reconnaissance craft proved incompatible with the deployment procedures undergoing test.

Engines used were Johnson 25 horse power (hp) with fitted propellor guard which proved adequate propulsion for all dive operations and transits. No engine failures occurred during testing or training, an outstanding performance for engines in continuous use for up to ten hours per day under heavy load conditions. Fuel economy was impressive, with only fifteen gallons being consumed for the entire period.

It became apparent that for marked swimming operations any platform of convenience with high maneuverability, low freeboard and minimal deck space can be used. For attended swimming however, a bow roller fairlead system is essential for the following reasons:

a. The weight of the clump and size of the clump line will cause extreme abrasion if in direct contact with rubber surfaces.

b. In conjunction with a ratchet winch it considerably reduces the effort required to deploy and recover the clump.

c. It ensures the craft lays correctly back from the clump in high seas.

d. The Lazy Shot can more easily be deployed to deeper depths.

For strength and rigidity it was discovered that the bow fairlead has to be secured to the keel of the surface platform. Attempts to secure the system to any other part of the boat will cause damage to the deck boards. For this reason the Navy MK I Swimmer Support Craft with a wooden keel has proven to be most suitable for this type of operation.

APPENDIX D shows technical drawings for the bow fairlead used for testing and is within the capability of manufacture of most machine shops. Construction is of aluminum. Fixing points are readily adaptable to most required configurations.

3. Communications. A one way voice communication system, diver to surface, was utilized during testing and is not intended for general use. Comprising a throat microphone, cord, small comms box and earpiece, the system was fitted to the Lazy Shot for use in an emergency. The system was battery powered and worked satisfactorily. The primary method of diver communications was line pull (APPENDIX A). The introduction of a shorter pull, called 'bell pulls' as they are signalled in groups of two, like striking a ship's bell, to enlarge the signal 'vocabulary' and minimize the possibility of signal confusion proved highly successful.

4. Diver Buoyancy Aid (Life Jacket). The life jacket used in conjunction with the MK 15 UBA was the USN MK 4. Despite excellent buoyancy and lift characteristics, the bulky construction of the jacket and the ease with which its CO_2 cartridges can be accidentally activated are major disadvantages in an environment where high diver mobility is required.

The toggle method of actuating the CO_2 cartridge inflation system gave particular cause for concern. A diver wearing a weight belt, UBA waist harness, and life jacket waist harness is encumbered around the midriff. Furthermore, use of life jackets designed around the horse collar concept, such as the MK 4, reduce the diver arm range of motion across the body. Due to this encumberance it proved easy to snag the toggle on other equipment causing inflation of the jacket and potential blow up. This occurred once at 40 FSW during training, fortunately without subsequent injury to the diver. If this had happened to a diver committed to decompression at maximum depth the consequences may have been more serious.

The size of the MK 4 adds a further burden to an already encumbered diver and was a source of continual complaint throughout testing. Due to design configuration, the diver has the size disadvantage of a buoyancy compensator without the associated buoyancy adjustment control.

The mandatory requirement for the use of a life jacket in attended swimming operations is of questionable value. The diver is tended throughout the operation and an alternative breathing source is always available at the first decompression stop. The U.S. Navy Diving Manual states that the purpose of the life preserver is to assist the diver in rising to the surface and to maintain him on the surface in a head up position. Actuation of the MK 4 at depth may result in an uncontrolled ascent causing the diver to travel shallower, or omit completely, the first required decompression stop.

A more acceptable procedure in this type of operation would be to establish positive buoyancy by the release of weight, thereby giving a controlled ascent to the first stop. By using the clump line the diver can hold himself at the stoppage depth. In attended swimming the diver's first recourse in the event of emergency is to travel to the Lazy Shot and emergency breathing system, satisfying the decompression requirement at the same time as reaching an alternative breathing source. Whenever a diver arrives on the surface he is under the positive control of the tender, arriving at the surface craft ready for immediate recovery. The use of a method of establishing positive buoyancy at the surface during marked swimming operations , however, should be mandatory.

5. Thermal Protection Systems. Due to relatively high ambient water temperatures during evaluation, practical testing of dry suits or passive thermal protection (other than wet suit) in conjunction with the procedures was not possible. A factor that will affect these procedures, therefore, will be the characteristics of any variable volume dry suit or passive thermal protection selected for use in ambient water temperatures of 60°F or less. Within the terms of this report high emphasis has been placed upon diver mobility. An unencumbered diver is better able to perform underwater tasks and when required to swim prolonged distances (as would be the case in marked swimming) a streamlined diver expends less effort.

B. Personnel. During evaluation the size of surface support crew was maintained at the most minimal level consistent with safety. It was found that the minimum desired level of manning in the surface craft should be three: one supervisor, one attendant and one standby diver. Two level states of readiness of the standby diver, relaxed and immediate, (as described in Section 3) allow the standby diver to act as a line handler, the diving

supervisor then tending the standby if required. A team of this size would be able to deploy one diver or one buddied pair for attended swimming operations and up to three single divers or three buddied pairs for marked swimming operations.

C. Procedures

1. Task and Mission Scenarios. Throughout testing, task scenarios were of two categories. The first category, that of an area search, used to locate an object. The second scenario was projected for tasks where the location of an object was known and required minimal relocation.

In the first category, diver bottom times are anticipated to be proportionately longer (greater than 30 minutes) due to the requirement to cover a wide area. In the second it was assumed that the tasking would be of identification or disposal, requiring a short dive profile (10-15 minutes bottom time). This latter type of operation is envisaged as the most commonly used method by a four man team configuration.

2. Depth Limitations. Due to the diversity of the two categories described above it is necessary to review 'marked swimming' and 'attended swimming' separately.

a. Marked Swimming. It was found that this operation should be limited to 150 FSW. This depth limit was established for the following reasons:

(1) An adequate period of no decompression bottom time is available from the decompression tables in the event of complication or failure early in the dive profile. This is considered prudent at a time when the surface crew is deploying more than one group.

(2) The Lazy Shot is easier to deploy on the light marker line at maximum decompression stop depths of 50 FSW or shallower.

(3) A diver cannot practically tow a marker float in depths greater than 150 FSW.

b. Attended Swimming. With a support crew of three this type of operation can be safely accomplished to 200 FSW. The deeper capability of this method is due to the advantages it has over the marked swimming operation described above, shown below:

(1) The diver is tended throughout.

(2) The Lazy Shot can be deployed to 10 FSW deeper than the first expected stoppage depth as soon as the diver leaves surface. In the event of an early dive termination the diver is able to conduct decompression immediately.

(3) The surface craft is stationary throughout the dive.

3. Standby Diver. A two level state of readiness was employed throughout testing. At the first level, the standby can be fully utilized as an additional line handler, a definite advantage in a small platform. Constant evaluation proved that a standby diver could be deployed from a relaxed state to leaving surface in an average time of 12 seconds from first indication of diver difficulty. A relaxed state was defined as:

a. Diver dressed in suit, weight belt and life jacket donned.

b. Fins and mask readily available.

c. UBA main bottles open with prescribed atmosphere established. Marker float attached to rig, float free to run.

The advantage of an "extra pair of hands" is judged as outweighing the disadvantage of a 12 second response delay for the majority of operations. The second level, 'immediate readiness', required that the standby be ready to enter the water immediately. Conditions which dictate that the standy diver should be at immediate readiness are described in APPENDIX A.

4. Equipment Preparation and Reports. After initial preparation in accordance with current documentation, the MK 15 UBA were used throughout an entire day's diving, changing canisters and gas flasks as required dependent upon planned profiles. The responsibility for pre-dive checks became that of the attendant/dive buddy immediately prior to putting the diver in the water in the format shown in APPENDIX A. The dive supervisor was responsible for sighting the diver before leaving surface to ensure no equipment leaks were present.

D. Table Validation. All dives shown in APPENDIX B were conducted in strict accordance with the 0.7 ATA constant partial pressure of oxygen in helium decompression tables shown in APPENDIX E. Dives were conducted as close to the actual depth and minute of bottom time contained in the tables as possible. No symptoms attributable to decompression sickness were reported during table use.

E. Emergency Facilities and Procedures. Of all factors affecting the size and nature of any required support facilities for these procedures, emergency contingencies will have the most far reaching consequences. The focal point of these contingencies will be the requirement for recompression facilities and what circumstances dictate they should be in the immediate proximity of diving operations. The final recommendation for RCC facilities is closely linked to the other components of the emergency procedure requirement; experience with decompression tables, equipment and deployment technique reliability are all considerations which govern the development of the emergency procedures. The objective of developed procedures is to ensure that the diver is safely able to complete the task with the minimum of hazard, consistent with operational and mission requirements. Each contributing aspect is, therefore, discussed in detail.

1. Emergency Breathing System. An area of concern during early procedural planning was the consequence to a diver of surfacing prior to required decompression due to a rig malfunction. To minimize the impact of a rig failure and to allow continued in-water decompression, an alternative

breathing source was required. It was clear that the method selected would have to be simple, reliable and easily deployable. Solutions such as hanging SCUBA cylinders or spare rigs at requisite stoppage depths were discounted due to the problems of deployment and imposing the additional stress of a rig change on an already anxious diver. As a Lazy Shot would already be deployed, it was considered that the method chosen to provide alternative breathing should be designed as part of the Lazy Shot itself. This would have the following advantages:

a. The system would be deployed as a matter of course whenever decompression was required.

b. The diver would only have to reach his first stop to find an alternative breathing source.

An umbilical configuration was therefore adopted, supplying a U.S.D. CONSHELF XIV SCUBA second stage regulator attached to the Lazy Shot. The emergency gas source was two 80 cu/ft SCUBA cylinders in the surface platform connected by a dual outlet manifold (SHERWOOD Model SVB-4000 KDE 48), supplying a USD Royal Aqualung first stage regulator. This allowed replenishment of the cylinders, SHERWOOD Model #A8000, from another source (a second set of cylinders for example) using an equalizing hose (DACOR 9901-00[E1]) without interupting the breathing of the diver. The maximum operating depth of the system was required to be 100 FSW, ten feet deeper than the first decompression stop for a diver from 200 FSW.

The problem of changing overbottom pressures at decreasing depth to maintain diver breathing comfort was overcome by the use of the U.S. Diver Royal Aqualung first stage regulator and large inside diameter hose to the second stage. Unmanned testing (reference 3) showed that when set to a pressure of 150 psig, this regulator is capable of providing satisfactory breathing characteristics at stable rates in depth ranges of 10 to 90 FSW without further first stage pressure adjustment. Breathing gas supply pressure was monitored by the use of a pressure gauge fitted directly to a high pressure outlet port on the first stage regulator.

Once the system was deployed and the main cylinders opened, no further surface operation was required until gas replenishment. This system satisfied the requirements of size and simplicity and was adopted as an integral part of the procedures. It was used extensively during training periods and was tested at 90 FSW in open water. It achieved 100% reliability throughout training and evaluation. Gas volume requirements for decompression are shown in Table 1. System components are shown in Table 2. Figure 1 is a block diagram showing emergency gas system components.

2. Decompression Tables. Despite being the subject of the most manpower intensive dive series ever conducted at the Navy Experimental Diving Unit and proven open water validity, 0.7 ATA O_2 in helium decompression tables cannot yet be considered reliable. Until a considerably larger base of manned data is acquired from operational use, incidence of bends cannot be accurately forecast. A second table validation requirement was apparent during planning for open water deployment; provision of an alternate breathing medium (described above) will necessitate a controlled evaluation to prove that decompression from 0.7 ATA tables can be safely achieved breathing air from an emergency breathing system. Procedures during testing (APPENDIX A) required a

TABLE 1

0.7 ATA CONSTANT PO2 IN He DECOMPRESSION TABLES:

Required Gas Volumes for Decompression from 200 FSW

RESPIRATORY MINUTE VOLUME 18 lpm (0.63 SCFM) (LIGHT WORK)

DEPTH FSW	ATA	CONSUMPTION (SCFM)	BOTTOM TIME (M)	TOTAL GAS VOLUMES REQUIRED FOR STOPS 15	20	25	30	40
10	1.3	0.82		8.2	18.04	19.68	19.68	63.96
20	1.61	1.01		10.1	10.1	24.24	24.24	24.24
30	1.91	1.21		6.05	12.1	14.52	29.04	29.04
40	2.21	1.4		5.6	14.0	14.0	19.6	33.6
50	2.52	1.61		4.83	9.66	16.1	16.1	38.64
60	2.82	1.79			5.37	16.1	17.9	26.85
70	3.12	1.98				3.96	19.8	19.8
80	3.42	2.17						21.7
			SAFETY FACTOR (10%)	3.47	6.92	10.8	14.6	25.7
			TOTAL VOL REQUIRED	38.25	76.19	119.4	146.36	283.5

Assuming a reserve of 500 psi(g) and a charge pressure of 3000 psi(g) twin SCUBA cylinders would have the following volumes at atmosphere pressure:

2 x 80 cu ft = 146.35 cu ft

NOTE: For arduous conditions such as extreme temperatures or heavy work, consumption figures should be doubled.

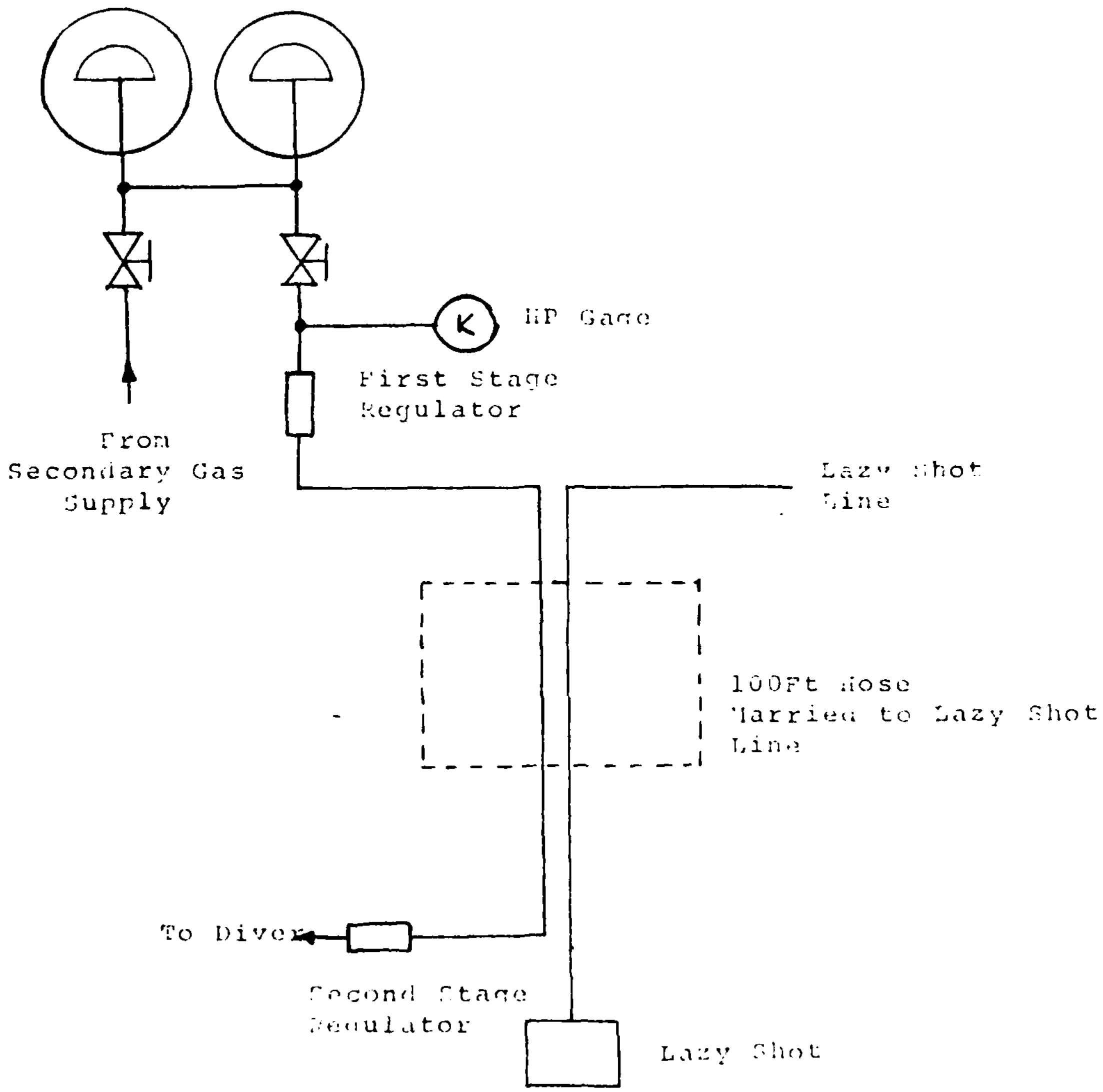
TABLE 2

EMERGENCY BREATHING SYSTEM (EBS) LIST OF COMPONENTS

MANUFACTURER	DESCRIPTION	MANUFACTURER MODEL NUMBER
Sherwood	SCUBA Cylinder 80 cu ft	A 8000
Sherwood	Manifold Dual Outlet	SVB 4000 KDE 48
U.S. Divers	Second Stage Regulator Conshelf XIV	1081
U.S. Divers	First Stage Regulator Royal Aqualung	101530
U.S. Divers	100 ft Umbilical 3/8" internal diameter	101525
DACOR	Tank Equalizer	9901-00[E1]

FIGURE 1

BLOCK DIAGRAM SHOWING EMERGENCY GAS SYSTEM COMPONENTS



diver experiencing primary rig failure to breathe air without changing depth until a second MK 15 UBA could be provided by the standby diver. Any time spent air breathing would be discounted for decompression purposes. The HeO_2 to air change was practiced extensively during dives to 60 FSW. For dives deeper than 60 FSW, air was provided solely for emergency use and was not utilized on a routine basis. Operationally, it would be desirable to continue decompression after changing to air using the 0.7 ATA PPO_2 in He tables for decompression without changing to a second UBA. This procedure will obviously require testing before being used in an operational environment. A final element of decompression table analysis is that there are no surface decompression tables available to supplement in water constant partial pressure tables. The only recourse presently available to minister to a diver unable to complete in water decompression or omitted decompression deeper than 10 FSW is application of therapeutic recompression procedures from the U.S. Navy Diving Manual.

3. Deployment Procedures and Equipment Reliability. The methods used to deploy divers to 200 FSW and safely recover them, performing requisite decompression in water, were highly successful and have a long history of proven reliability with the Royal Navy. In addition to this reliability and success, a new system, the emergency breathing system, has been developed to enhance diver safety. Emergency procedures have not been developed, therefore, to supplement the deployment procedures but to provide measures of response to a major trauma or rig malfunction. Until considerably more man dives have been achieved in water utilizing the MK 16, rig malfunction should be counted as high probability when developing emergency procedures, albeit probably inflated.

4. Emergency Procedures. The emergency procedures developed for use during the test period (APPENDIX A Part II) were designed to fulfill the anticipated requirements of an experimental dive series and to allow that dive series to be conducted. In the light of experience gained during testing, no immediate modification of the emergency procedures are envisaged. Current lack of: (a) surface decompression tables, (b) proven constant partial pressure decompression tables, (c) valid air breathing decompression using constant PPO_2 tables, and (d) reliability figures for the MK 16 MOD 0 UBA, dictate that the emergency procedures for operational use, for the time being, should remain the same as EPs used for testing, no alternative being presently available.

5. Recompression Facilities. A major consideration in EOD operations should be to maintain the capability of rapid response to diverse tasks with maximum mobility. As a consequence, and in addition to EP requirements, the recommendation for Recompression Chamber (RCC) facilities is governed by the type of task likely to be encountered and the interface between task time, depth and requisite decompression. An attended swimming operation, for example, would be deployed when the location of an object is accuratly known. Assuming that the task was to identify, neutralize by explosive or to attach a recovery line, it was found that even in poor visibility typical total bottom times were at maximum between ten and fifteen minutes. Allowing an additional five minute safety margin, a dive could be conducted to 110 FSW without reasonably expecting to perform decompression (APPENDIX A Part III). It would be feasible to conduct diving operations to 110 FSW without RCC facilities on site (on site meaning within 200 yards if

carried by a surface platform) or within ten minutes of leaving bottom if ashore. (Ten minutes is selected as the standard U.S. Navy surface interval.)

For dives of depths greater than 110 FSW the no decompression margin reduces considerably and if a 15 minute task time is again assumed, the likelihood of a decompression requirement is increased.

Under normal circumstances, it can be proposed that RCC facilities are primarily available during diving operations to treat a diver omitting required in water decompression. This risk is, in part, reduced by the provision of an alternative breathing source, circumventing the consequences of rig failure. A second, and perhaps more important reason for provision of RCC facilities where decompression is expected using 0.7 constant partial pressure tables, is the lack of operational open water diving experience presently available from their use. The possibility of the onset of decompression sickness resulting from their use cannot be totally discounted.

With an emergency breathing system available, noting that the RCC would only be used in the extreme situation, and until sufficient operational dives are done to attest to the expected incidence of decompression sickness, it is considered that RCC facilities should normally be available for dives deeper than 110 FSW where decompression is expected. To establish a deep operational capability, however, diving operations of the type described in this report should be permissable to 200 FSW without RCC facilities on site, if the operational considerations, as adjudged by the on scene commander, justify the additional risk. When arriving at this decision he should give consideration to: (a) task type; (b) environmental factors; and (c) experience of the team.

6. In conclusion, it is anticipated that as further experience is gained in table and equipment usage and emergency air decompression manned data becomes available, emergency procedure and recompression facility requirements may be modified.

V. CONCLUSIONS

1. All test objectives were met during evaluation. As a result of experience gained during testing specific changes have been made to the procedures proposed in reference 1 and are shown in a fully revised form in APPENDIX A.

2. As a result of testing, the operating parameters for these procedures can be accurately established for a four man team. Regardless of surface support crew size, the practical depth for marked swimming operations is 150 FSW. In consideration of the amount of line, hose and weight to be deployed for attended swimming the practical depth limit is 200 FSW.

It is evident, however, based upon experience gained during testing, that with only marginal support facility increase, deployment of the self contained diver to 300 FSW performing requisite decompression in water is a realistic objective. Extension of the mixed gas SCUBA (MGS) capability to 300 FSW can be achieved by utilizing a basis of the procedures already tested and detailed in APPENDIX A.

3. Consideration should be given to the compatability of any thermal protection systems projected for use with these procedures within the constraints of the confined space of an inflatable craft and EOD diver tasking. Bulk of suit construction, extraneous inflation systems and leg/waist weights will all affect the comfort of the diver on the surface for a prolonged period of time, in-water mobility, and dictate the degree of difficulty with which the diver can be dressed and deployed or recovered.

4. Despite the proven safety of HeO_2 to air changes during decompression in a foreign military and commercial environment, it is highly desirable that the concept of air decompression using constant partial pressure of oxygen decompression tables be validated in a controlled environment and the subject of an experimental dive series.

VI. REFERENCES

1. NEDU Test Plan 83-15.

2. BR 2806 Royal Navy Diving Manual.

3. NEDU Technical Memorandum TM5-83.

APPENDIX A

REGULATIONS FOR DEPLOYMENT OF THE MK 16 MOD 0 UBA

I. DEPLOYMENT AND DECOMPRESSION PROCEDURES

II. EMERGENCY PROCEDURES

III. 0.7 ATA CONSTANT PARTIAL PRESSURE OF OXYGEN IN HELIUM DECOMPRESSION TABLES

IV. 0.7 ATA CONSTANT PARTIAL PRESSURE OF OXYGEN IN NITROGEN DECOMPRESSION TABLES

APPENDIX A

PART I

DEPLOYMENT AND DECOMPRESSION PROCEDURES

Procedures presented in this section are designed for use with the MK 16 UBA using nitrogen oxygen or helium oxygen mixture diluents. The procedures allow safe decompression of divers deployed to 200 FSW to be conducted in water from a small surface craft with minimal surface support. Constant partial pressure of oxygen in helium or nitrogen decompression tables have been specifically designed for use with the MK 16 UBA and are to be used with the deployment procedures described in this section.

1.1 General Considerations. It is essential in these type of operations that the dive team is in regular diving practice and fully conversant with all procedures and emergency procedures. A minimum standard of half diving practice should be at night or in conditions of restricted visibility.

2. Decompression in the Water. Stops in mixed gas SCUBA (MGS) are never to be undertaken when swimming free. The diver must always be on a clump line or Lazy Shot. It is imperative that the divers' maximum depth of dive and depth at any time during stops is known accurately. The maximum depth of the dive can be obtained from soundings which should be taken over the whole area covered by the diver.

2.1 A diver's depth taken from a clump line or life line will only be accurate when the line is vertical in the water. This should be kept in mind if the dive platform is swinging with wind or tide.

2.2 Control of An Attended Swimmer's Ascent (Figure 2). A swimmer, attended from a platform using a clump line, is to be surfaced using a Lazy Shot, as described in Article (10.3). Before the diver is called to the surface, the Lazy Shot is clipped to the clump line and lowered to a depth 10 ft deeper than the swimmer's first stop. The diver is then called up by four pulls and ascends on the clump line at a steady rate of 60 FPM to the lazy shot. On arrival at the shot, the diver signals the surface and remains at the shot; the attendant hoists the shot to the first stoppage depth and continues to control diver decompression by hoisting the shot to subsequent stoppage depths at the intervals given in the decompression tables.

2.3 Control of a Marked Swimmers Ascent (Figure 3). A swimmer marked with a swim marker is surfaced by use of the lazy shot as described in Article (10.3). The attendant craft closes the float and on the float line clips the lazy shot; the shot is lowered to 10 ft below the diver's first stop. The diver is then signaled to come up using the float line. The float line is then taken in and the diver guided to the shot. On arrival at the shot the diver signals the surface and remains at the shot, the attendant hoists the shot to the first stoppage depth and continues to control the diver's decompression by hoisting the shot to the subsequent stoppage depths at the intervals given in the decompression table.

4. Conduct of EOD and MCM Diving Operations in Mixed Gas Scuba (MGS) (MK 16 UBA)

a. It is essential in these type of operations that the dive team is in regular diving practice and fully worked up.

b. Whenever recompression facilities are available on a surface platform, it is to remain within 300 yards of a dive involving stops, with recompression facilities on immediate standby.

c. It is obvious that it is always safer for divers to work in pairs rather than singly. However, in doing so, diver time expended is doubled and could prejudice the successful completion of the mission. It is permissible therefore in Explosive Ordnance Disposal and Mine Counter Measures tasks for the swimmer to operate singly down to the limits indicated in Table 3. The decision whether to operate singly or in pairs will rest with the on-site Supervisor who should take into consideration the following factors:

(1) Diver experience

(2) Environmental conditions

(3) Degree of urgency

5. Standby Diver. A standby diver is required at the surface for all MGS operations. He should be available at short notice and be dressed in the same breathing equipment as the diver, having a depth marked marker float free to run attached. The standby UBA is to be rigged with the same diluent as that being used for operation. Before diving, the standby diver should be fully dressed and have been checked for leaks underwater. If practicable, he should descend to 20 FSW to ensure he can clear his ears. After testing, breathing equipment should be available for 12 hours, at the end at which, the CO_2 absorbent should be changed. Under the following circumstances the standby diver should be at immediate notice:

a. When diving on wrecks

b. In tidal streams greater than 0.5 kt current

c. Hazardous conditions

d. At the Supervisors discretion

Immediate notice for MK 16 is defined as:

a. The diver fully dressed including UBA, marker line, life jacket, fins, weight belt and mask.

b. Main valves open, mouthpiece cock at surface.

5.1 At all other times the standby should be at short notice to enter the water. This is defined as follows:

a. Diver dressed in appropriate thermal protection, weight belt and life jacket donned.

b. UBA fully prepared with lifeline free to run attached; appropriate partial pressure of oxygen established; harness slack, ready to don.

c. Facemask and fins readily available.

6. Definitions of Swimming

a. Marked Swimming. Underwater swimming in self-contained diving equipment wearing a light, depth marked line, attached to a light float at the surface.

b. Marked Swimming in Pairs. Underwater swimming in pairs attached to each other by a buddyline with one swimmer wearing a light, depth marked line attached to a light float at the surface.

c. Attended Swimming. Swimming in self-contained diving equipment using a clump and line, wearing a light, depth marked line, attached to a light float at the surface which is continuously kept in hand by an attendant.

Selection of the type of swimming to be used for any specific task should take into consideration the following:

(1) Depth (see Table 3).

(2) Type of search employed

(3) Area to be covered

(4) Environmental conditions

(5) Number and experience of divers available

7. Supervision of MGS Operations. Not allocated.

8. Authorized Diving Limits. In an emergency, when the depth of the water in which a diving operation is taking place is greater than the authorized diving limit, the Standby diver may, at the discretion of the Supervisor, dive to the limit of his equipment in order to save life (Table 3).

TABLE 3

TABLE OF AUTHORIZED DIVING LIMITS

Type of Diver	Swimming			
	MK 16 Diluent	Attended	Marked in Pairs	Marked
EOD Diver	HeO_2	200 FSW	150 FSW	150 FSW
	N_2O_2	150 FSW	150 FSW	150 FSW

NOTE

EQUIPMENT LIMIT USING THE MK 16 UBA AND A DILUENT OF HeO_2 IS PRESENTLY 300 FSW

9. Minimum numbers required to support diving operations in the EOD/MCM environment are as follows:

a. Operations of maximum depth 200 FSW:

1 Supervisor (also acting as standby attendant)

1 Standby Diver

1 Attendant - For each diver or pair of divers conducting attended swimming operations.

OR

1 Attendant - For each diver or pair of divers up to a total of six divers conducting marked swimming operations.

b. Operations of depth greater than 200 FSW:

Procedures are in development to dive deeper than 200 FSW.

10. Equipment for use in EOD/MCM Operations. Equipment available from Naval Stock is shown in Table 4.

10.1 Surface Platform. The MK 1 Swimmer Support Craft is available for issue to EOD detachments and it, or similar, should be used to support these operations. Where this craft is not available the chosen platform should fulfill the following requirements.

a. Low freeboard

b. Good reserve of buoyancy characteristics

c. Rigid keel (for operations deeper than 150 FSW)

d. High degree of maneuverability

10.2 A bow fairlead system of the configuration shown in Figures 4 and 5 should be locally manufactured and is to be used for all attended swimming operations.

10.3 Lazy Shot and Emergency Breathing System. This system is designed as an accurate and reliable method of controlling a divers' ascent during decompression and to provide an alternative breathing source for a decompressing diver in the event of primary rig failure. It is to be available at any time decompression is expected. Components of the system are shown in Figures 6 and 7 and Table 5 comprise the following.

a. Lazy Shot. A light sinker attached to a line marked in accordance with 10.4. A spring clip hook, rope loop or karabiner is secured to the sinker to allow it to be married to a float line or clump line in accordance with 2.2 and 2.3. Metal rings of 1 inch diameter are spliced to the Lazy Shot line at intervals of approximately 3 feet.

b. Emergency Breathing System. A conventional SCUBA second stage regulator (USD CONSHELF XIV No. 1081) is secured to an umbilical of length 110 feet and internal diameter 3/8 inches. The umbilical is passed through the rings of the Lazy Shot line and secured to a U.S. Divers Royal Aqualung first stage regulator (No. USD 101530) set to an overbottom pressure of 150 psig. Additionally, a high pressure gauge is to be fitted to the first stage to allow continuous monitoring of emergency gas pressure.

c. Emergency Gas Supply Source. Twin 80 cu ft SCUBA (SHERWOOD A800) bottles with dual outlet manifold (SHERWOOD SVB 4000 KDE48) allowing gas replenishment without interupting breathing, carried in the surface platform (Figure 7). Volume requirements are shown in APPENDIX A PART II.

10.4 Marking of lines. All lines used for controlling the depth of the diver are to be marked as detailed below. This includes lifelines, marker lines, clump lines, lazy shot lines and lost diver marker.

a. The following standard marking code is to be adopted; lines are to be marked every 50 feet from the diver's end by one red band for every multiple of 50 feet (e.g. the 150 foot mark would have three red bands). In addition, each 50 ft length is marked at each intermediate 10 ft by a yellow band for every multiple of 10 ft e.g. The 40 ft mark would have four yellow bands (i.e. 4 x 10 ft). The 120 ft mark would have two red bands and two yellow bands (i.e. 2 x 50 ft and 2 x 10 ft).

b. Lines are to be marked using turns of 1/2 inch colored adhesive tape 1/4 inch apart. Rope, whether Man Made Fibre (MMF) or natural, can be marked by reaving the tape through the strands and then taking two complete turns around the rope. The tapes are to be so applied that the lower one, or the first tape of a numerical combination to enter the water is at the depth to which that combination refers.

10.5 Divers Clump. The clump can consist of any conveniently shaped heavy weight to which a rope is secured for the diver's ascent and descent. The optimum size is 50-75 kg (110-160 lbs). It is important that the clump does not move because this will negate any search being conducted. For this reason, in certain circumstances it may be advantageous to attach a tail of 10 ft and a small non-magnetic anchor to the clump.

10.6 Clump Rope. The clump rope should normally be 50 ft longer than the maximum depth expected and whenever practical, capable of a lifting strain comparable to the weight of the largest size dummy ordnance expected. The first 30 ft of the clump rope is designated as a distance line and an eye splice is rove at the end with a shackle. At the 30 ft mark a 3 ft tail should be spliced into the clump rope. This tail should then be shackled to the clump. Markings (Art. 14.4.17.3) should then be made from the clump, ignoring the distance line, to the other end of the clump rope, where provision should be made to enable a marker float to be easily attached.

10.7 Diver Swim Marker

a. Swim markers are to be 10 inch spherical floats made of a form of expanded polystyrene. A 3/4" wooden stave is passed through the center of the

float and extends approximately 8" each side. The float line, made of light MMF rope is also passed through the float and made fast on its own part. The length can be adjusted by figure eight turns round the float.

b. The float line is to be marked in accordance with Article (10.4).

c. The float line should be secured to the diver by a bowline or screw gate spring hook and should not interfere with ditching routines.

d. The float is merely a marker and will not support the weight of a diver in the water and the float line is not strong enough to lift the weight of a diver.

10.8 Buddylines. When the divers are operating in pairs they are to be joined by a buddyline approximately nine feet in length, which should not interfere with UBA ditching.

11. Night Operations. When diving at night, indicating lights are to be fitted to the diver and marker floats. Additionally, each diver is to wear a strobe light marker on the left forearm and carry a flare. Diver indicating lights are to be activated in the event of emergency. Marker float lights are to be actuated for all night diving operations.

12. Lost Diver Marker.

a. Lost diver marker is to be made from a 3/4" stave, thirty inches in length. A semi spherical polystyrene float is to be fixed at each of the stave and painted day glo orange. A light MMF rope is secured to the stave and turns taken around the stave for the length of the rope. The rope end should be secured to a sinker of 25 kg (50 lbs) weight. A distance line of 30 ft length should be secured to the sinker.

b. The line is to be marked in accordance with Article (10.4).

c. The lost diver marker is to be readily available during all diving operations.

d. In the event of a lost diver, the lost diver marker should be thrown overboard at the last known diver position. On dropping to the sea bed the marker will provide a datum for the standby diver from which to conduct a search.

e. The marker may also be utilized for depth soundings.

13. <u>Communications</u>. Float line signals are to be used between the diver and the surface where other communications are not available. When marked swimming, divers make their signals by pulling on the floatline and causing the float to bob. The boat will have to move to the float to signal back. Due to the possibility of confusion in these type of operations, the following code should be used when diving in an EOD/MCM environment.

a. Signals are of two types:

(1) Pulls. Long, steady and distinct pulls ______ _______ (2)

(2) Bells. Short, sharp bell pulls, signalled in groups of two .. .. . (5) As if striking a Ships Bell

b. Signals should always be preceded by 1 pull to call attention.

c. Attendant to diver

1 pull	To call attention Stop where you are (if traveling)
2 pulls	Sending down a ropes end (or as arranged)
3 pulls	You have come up too far. Go down until we stop you.
4 pulls	Come up
4 pulls 5 bells	Come up your marker float
6 bells	Unclip the lazy shot

Direction Signals

2 bells	Go to the end of the distance line or jackstay
3 bells	Face clump - go right
4 bells	Face clump - go left
5 bells	Come into your shot, or turn back if on jackstay

d. Diver to Attendant

1 pull	To call attention Made Lazy Shot
	Made bottom
	Left bottom
	I am well
2 pulls	Send a ropes end (or as arranged)
3 pulls	I am going down
3 pulls 2 bells	I have decompression sickness symptoms
4 pulls	May I come up?
4 pulls 2 bells	I want to come up - rig malfunction

Succession of Pulls - Emergency Signal
(must be more than 4)

Succession of 2 bells - Am foul and require the assistance of of another diver

Working Signals:

1 pull	Hold on or stop
2 bells	Pull up
3 bells	Lower
4 bells	Take up slack lifeline or you are holding me too tight
5 bells	Have found, started or completed work
6 bells	Breathing from Emergency System

NOTE: 1. Signals to be replied as given.

2. Emergency signal. Unless the diver is clearly travelling, no attempt should be made to haul the diver to the surface, due to the potential to compound an already critical situation. It should be left to the standby diver to render appropriate assistance underwater.

14. Reports. To ensure uniformity and prevent confusion the following report is to be made by the attendant (1 diver) or respective buddy (2 divers) to the supervisor immediately before the divers enter water.

"Diver ___ dressed, lifeline/buddyline passed, both main bottles open, oxygen pressure ___, diluent pressure ___. Primary display correct, secondary display correct, battery checked and good. Connections checked, ready to go on gas."

On direction from the supervisor the diver is put on gas and the report is made by the tender.

"Diver ___ on gas; ready for the water" or a "thumbs up" is given if buddied.

The following procedure is to be followed once the supervisor has given instruction to put the divers in the water.

a. Single Diver. The lifeline is kept in hand by the tender. The supervisor ensures no leaks and the diver is told to leave surface. The float is then thrown away from the boat by the tender if marked swimming.

b. Diving in Pairs. The diver with the marker float enters the water first. The line is kept in hand by the tender. The second diver then enters the water and connects the buddy line. The connections are then held above the surface for supervisor sighting. On completion of sighting, divers will then check each other for leaks, indicating well, or otherwise to the boat. Divers will then leave surface, the float being thrown away from the boat by the tender if marked swimming.

NOTE: The tender is to ensure correct timing of the dive by verbal report "left surface" to the supervisor.

15. Duties of the Attendant During Diving Operations. In addition, to generally aiding the diver(s), ensuring correct dressing and safe entry and recovery of the diver(s), the attendant is responsible to the supervisor for the correct passage of signals to and from the divers. He is to ensure that the supervisor is aware of the location of the diver(s) or dive marker float at all times. He is to constantly tend the marker line or watch the marker float. All directions and instructions from the supervisor are to be repeated back verbatum. The attendant is to ensure by verbal report that the dive supervisor is aware of the following.

a. Diver(s) left surface.

b. Diver(s) made bottom.

c. Diver(s) left bottom.

d. Diver(s) made Lazy Shot.

e. Diver(s) on the surface.

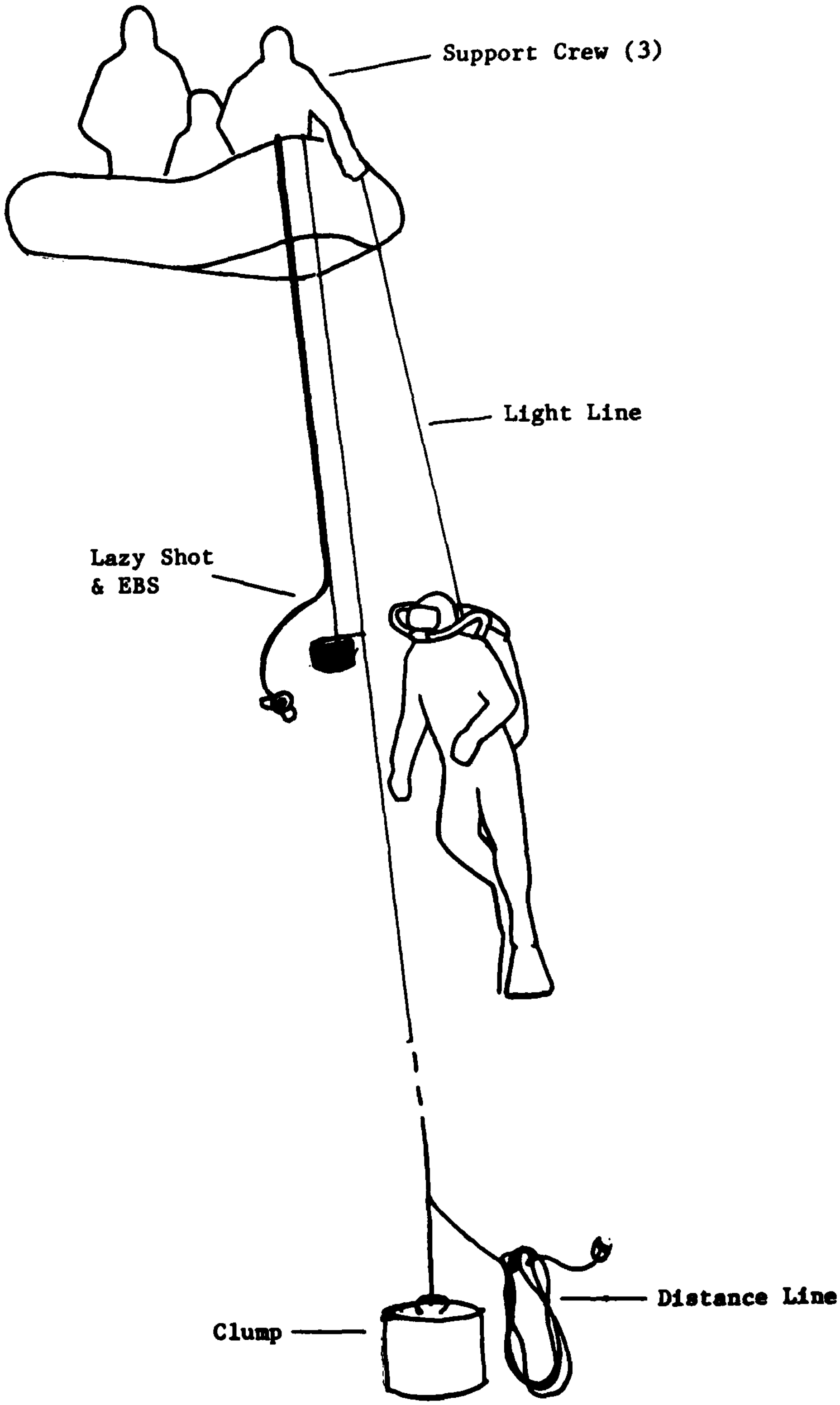


Figure 2; In Water Decompression - Attended Swimming

Figure 2.1: Diver Dressed for Swimming Operations

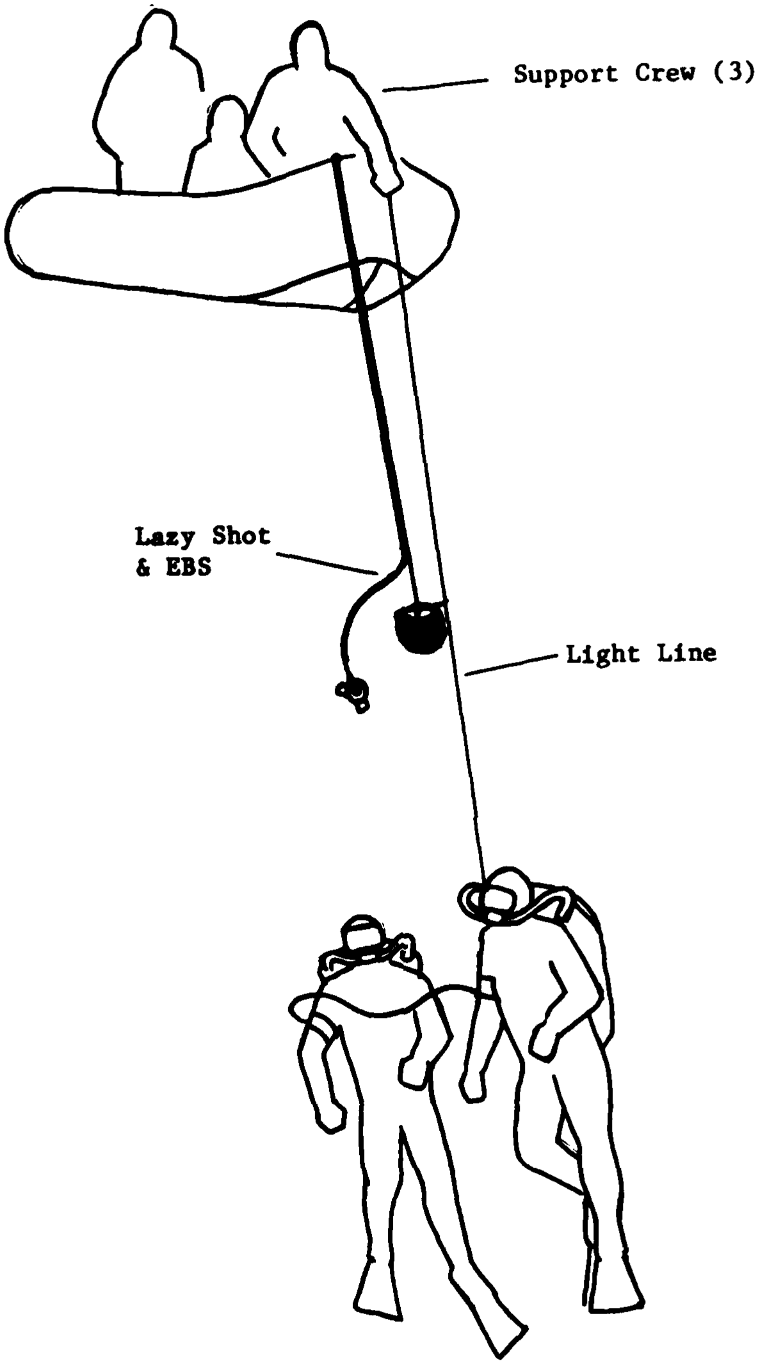


Figure 3: In Water Decompression - Marked Swimming Ascending to Lazy Shot

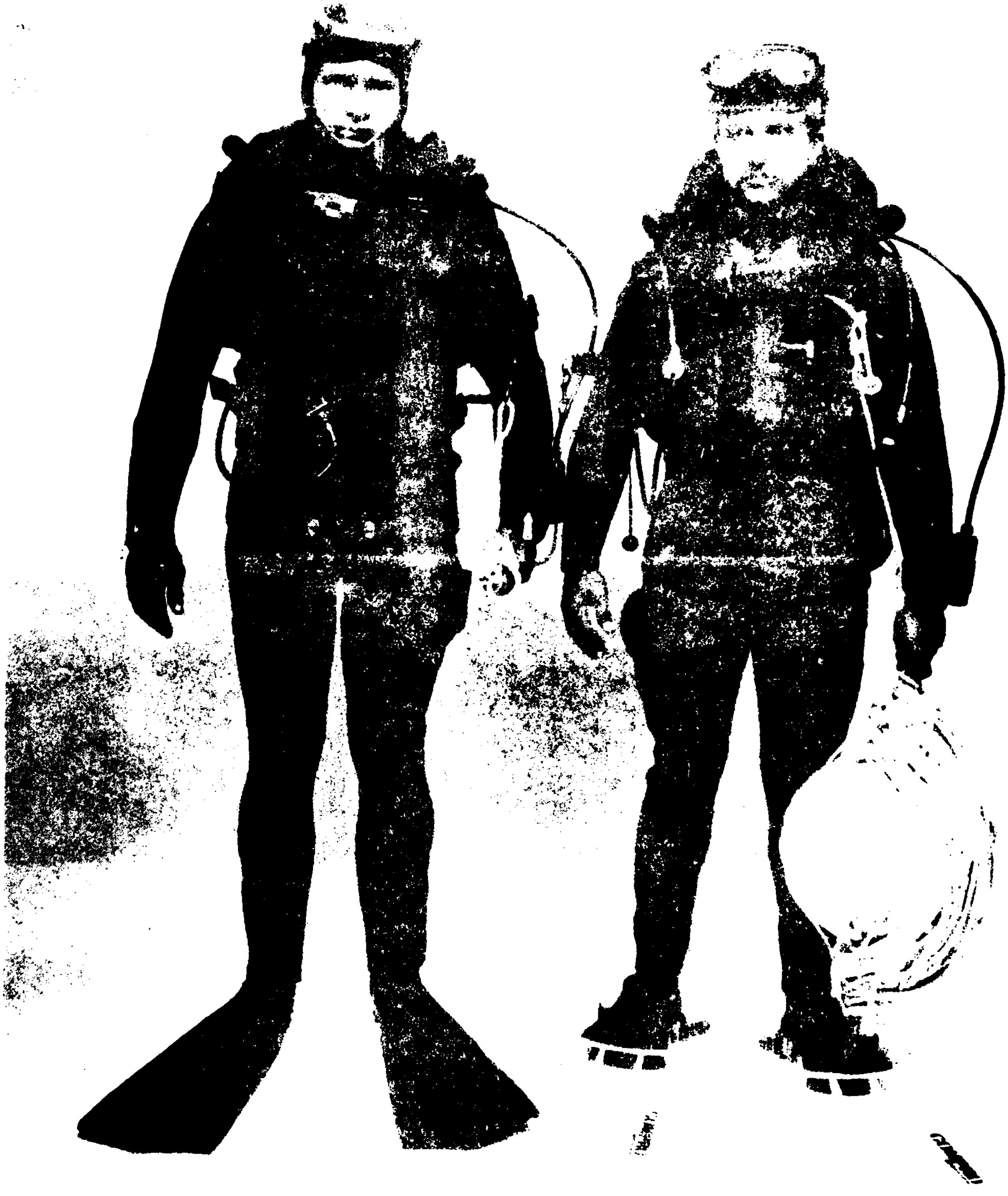


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Figure 4. Bow Fairlead

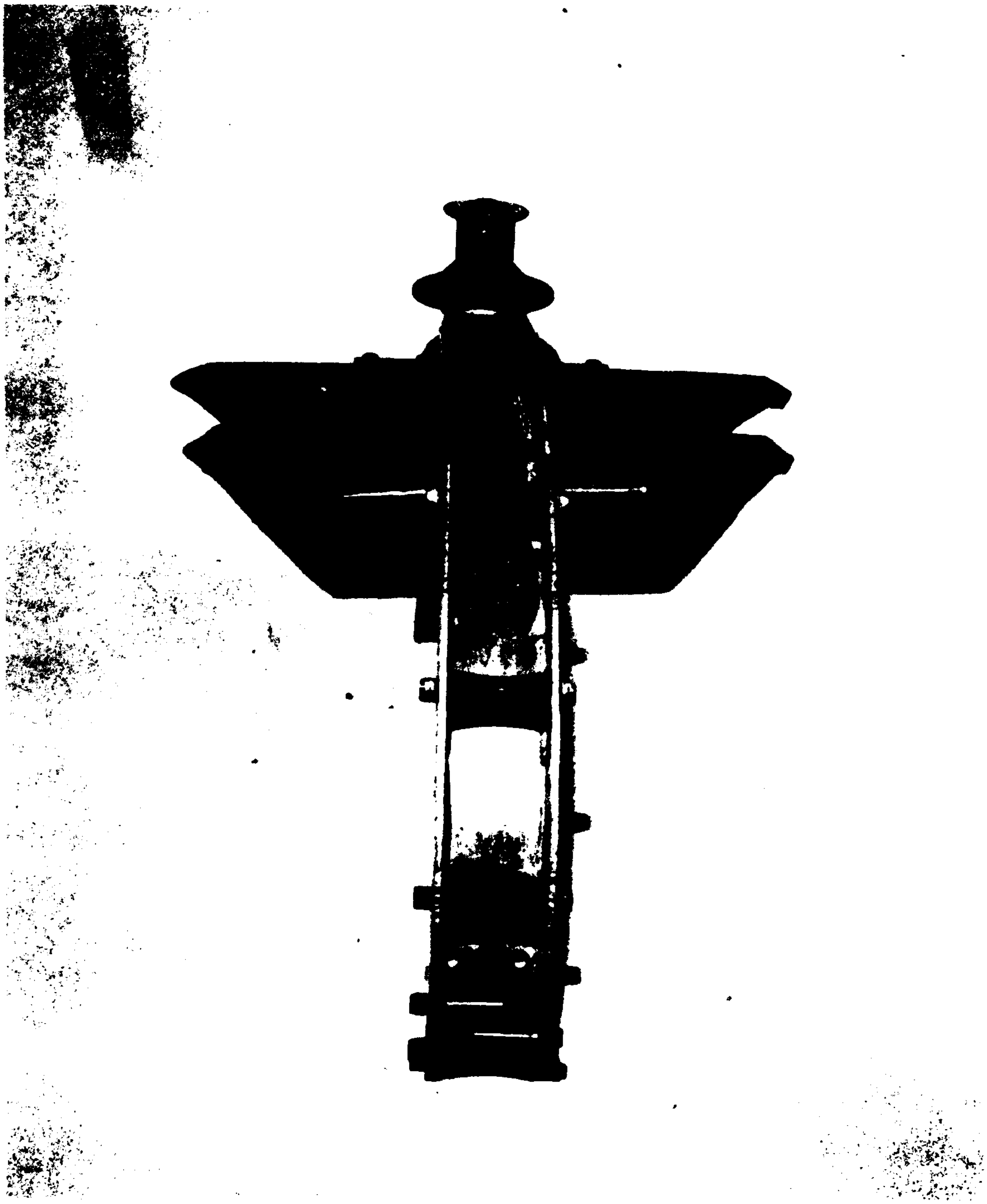


Figure 5. Bow Fairlead

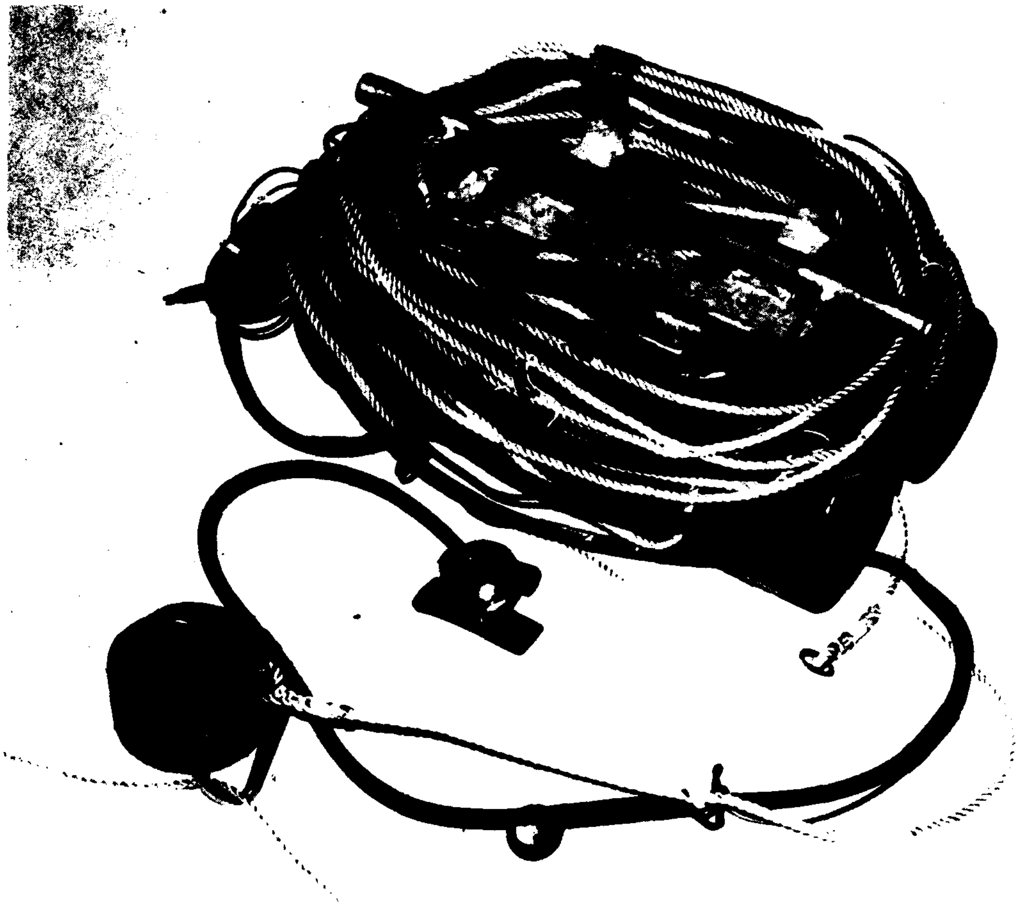


Figure 6. Emergency Breathing System and Lazy Shot

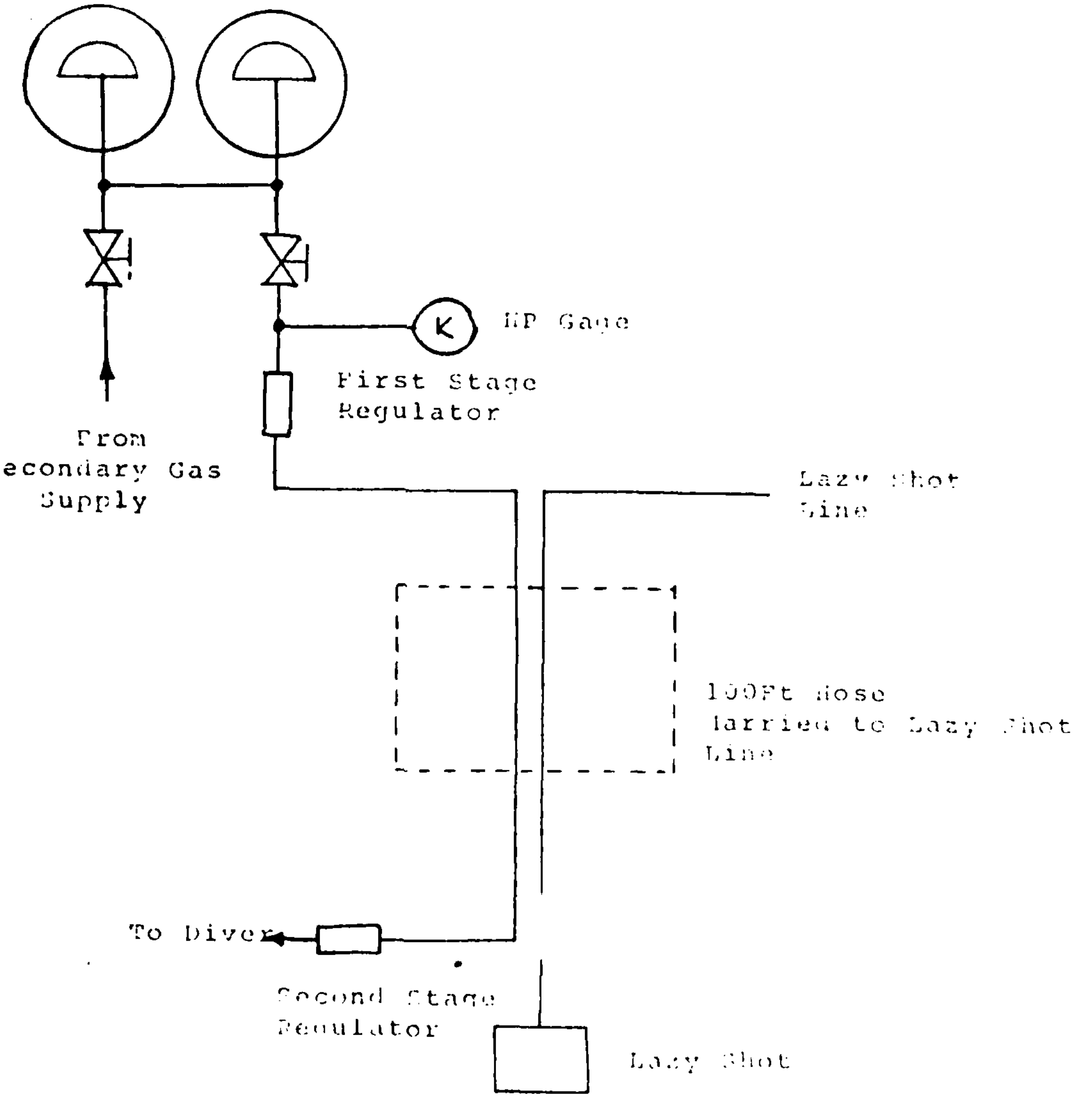


Figure 7. Block Diagram Showing Emergency Gas System Components

TABLE 4

NAVAL STOCK ITEMS FOR DEPLOYMENT USE

NAVAL STOCK NUMBER	DESCRIPTION	REMARKS/USES
4020.00.968.1354	Rope, Polypropylene 3/4"	Clump Line, Descent Line
4020.00.968.1350	Rope, Polypropylene 1/4"	Float Line, Lazy Shot Lost Diver Marker
4020.00.240.2146	Cord, Braided 3/16"	General, Jackstay
5510.00.240.0071	Wood Dowel 3/4"	Marker Floats
5340.00.275.4584	Snap Hooks	General, Jackstay
4030.00.242.5575	Shackle 3/4"	General
6260.00.106.7478	Lights, Chemical	Diver Indicating Lights Float Marker
8010.00.958.8148	Paint, Fluorescent Orange	Marker Floats, Lost Diver Marker

TABLE 5

EMERGENCY BREATHING SYSTEM (EBS) LIST OF COMPONENTS

MANUFACTURER	DESCRIPTION	MANUFACTURER MODEL NUMBER
Sherwood	SCUBA Cylinder 80 cu ft	A 8000
Sherwood	Manifold Dual Outlet	SVB 4000 KDE 48
U.S. Divers	Second Stage Regulator Conshelf XIV	1081
U.S. Divers	First Stage Regulator Royal Aqualung	101530
U.S. Divers	100 ft Umbilical 3/8" Internal Diameter	101525
DACOR	Tank Equalizer	9901-00[E1]

APPENDIX A

PART II

EMERGENCY PROCEDURES

Procedures and regulations presented in this section are designed for use with the MK 16 UBA where in water decompression procedures are to be employed.

1. Recompression Facilities. For operations in water depths greater than 110 FSW, where decompression is expected, a recompression facility should normally be available on site. Where this is not possible the mission considerations should justify the additional risk. Mixed gas SCUBA operations deeper than 200 FSW are not to be undertaken unless a recompression facility is available on site. In all circumstances 'on site' means the diver must be able to leave bottom, ascend at 60 FPM and reach chamber bottom within ten minutes.

2. Surface Decompression. When using mixed gas SCUBA (MGS), surface decompression is only to be attempted as a last resort in the event of critical dive medical or equipment emergency. A diver omitting decompression deeper than 10 FSW, will presently always require theraputic recompression and subsequent theraputic decompression.

3. Emergency Breathing System (EBS). As described in Appendix A, Part I, the EBS is designed to augment the diver's primary breathing equipment and circumvent premature surfacing in the event of primary breathing system failure. It is to be deployed whenever decompression is anticipated. In the case of UBA malfunction during dives requiring decompression, the diver should make every attempt to reach the lazy shot and conduct decompression. In all cases of UBA failure or malfunction, the diver should transfer to the emergency breathing system at the lazy shot as soon as possible. When marked swimming, the diver should, wherever possible, wait for an answering signal from the surface before starting ascent. This will allow sufficient time for the lazy shot to be lowered. Consumption figures for provision of emergency gas volume requirements are shown in Table 6.

4. Emergency Procedures. In all in-water emergency situations a diver should make every effort to complete required decompression at the lazy shot, utilizing emergency systems as necessary. This will obviously not be practical if a situation or equipment malfunction is immediately life threatening, however, the diver should be aware that omitting decompression is potentially hazardous and will always require theraputic action.

TABLE 6

0.7 ATA CONSTANT PO_2 IN He DECOMPRESSION TABLES:

Required Gas Volume for Decompression from 200 FSW

RESPIRATORY MINUTE VOLUME 18 lpm (0.63 SCFM) (Light Work)

DEPTH FSW	ATA	CONSUMPTION (SCFM)	BOTTOM TIME (M)	TOTAL GAS VOLUMES REQUIRED FOR STOPS				
				15	20	25	30	40
10	1.3	0.82		8.2	18.04	19.68	19.68	63.96
20	1.61	1.01		10.1	10.1	24.24	24.24	24.24
30	1.91	1.21		6.05	12.1	14.52	29.04	29.04
40	2.21	1.4		5.6	14.0	14.0	19.6	33.6
50	2.52	1.61		4.83	9.66	16.1	16.1	38.64
60	2.82	1.79			5.37	16.1	17.9	26.85
70	3.12	1.98				3.96	19.8	19.8
80	3.42	2.17						21.7
			SAFETY FACTOR (10%)	3.47	6.92	10.8	14.6	25.7
			TOTAL VOL REQUIRED	38.25	76.19	119.4	146.36	283.5

Assuming a reserve of 500 psi(g) and a charge pressure of 3000 psi(g) twin SCUBA cylinders would have the following volumes at atmosphere pressure:

2 x 80 cu ft = 146.35 cu ft

NOTE: For arduous conditions such as extreme temperatures or heavy work, consumption figures should be doubled.

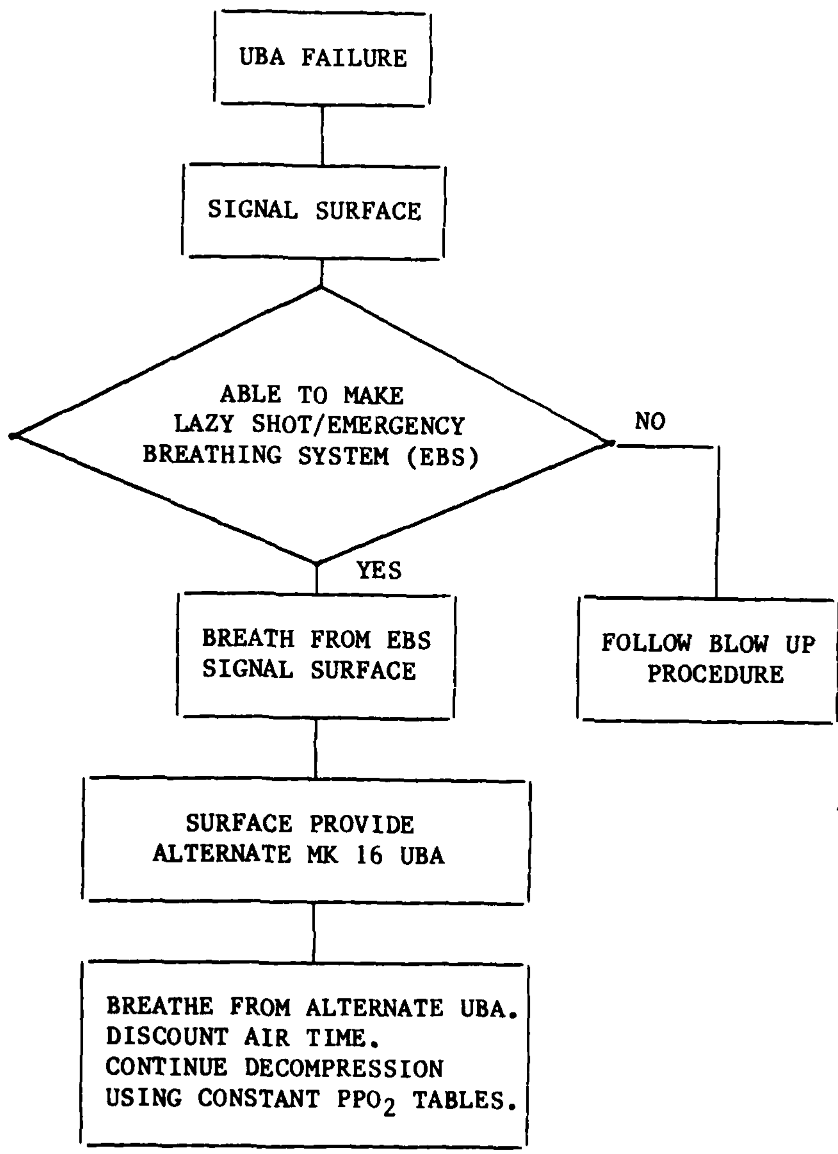
4.1 Emergency Procedures. Detailed below are the procedures to be followed in the event of the categorized problems.

a. Primary UBA failure.

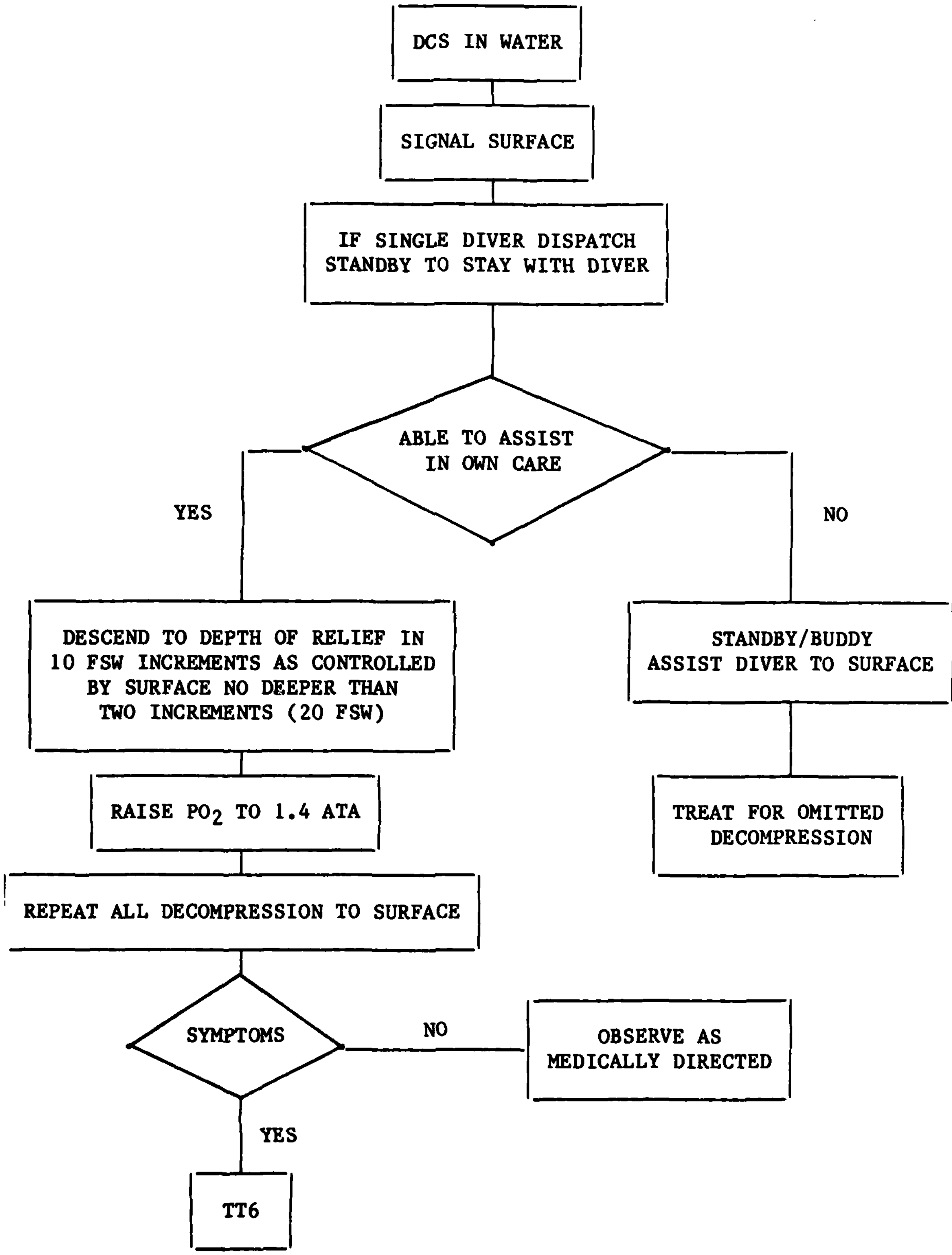
b. Ommitted decompression.

c. Decompression sickness symptoms in water.

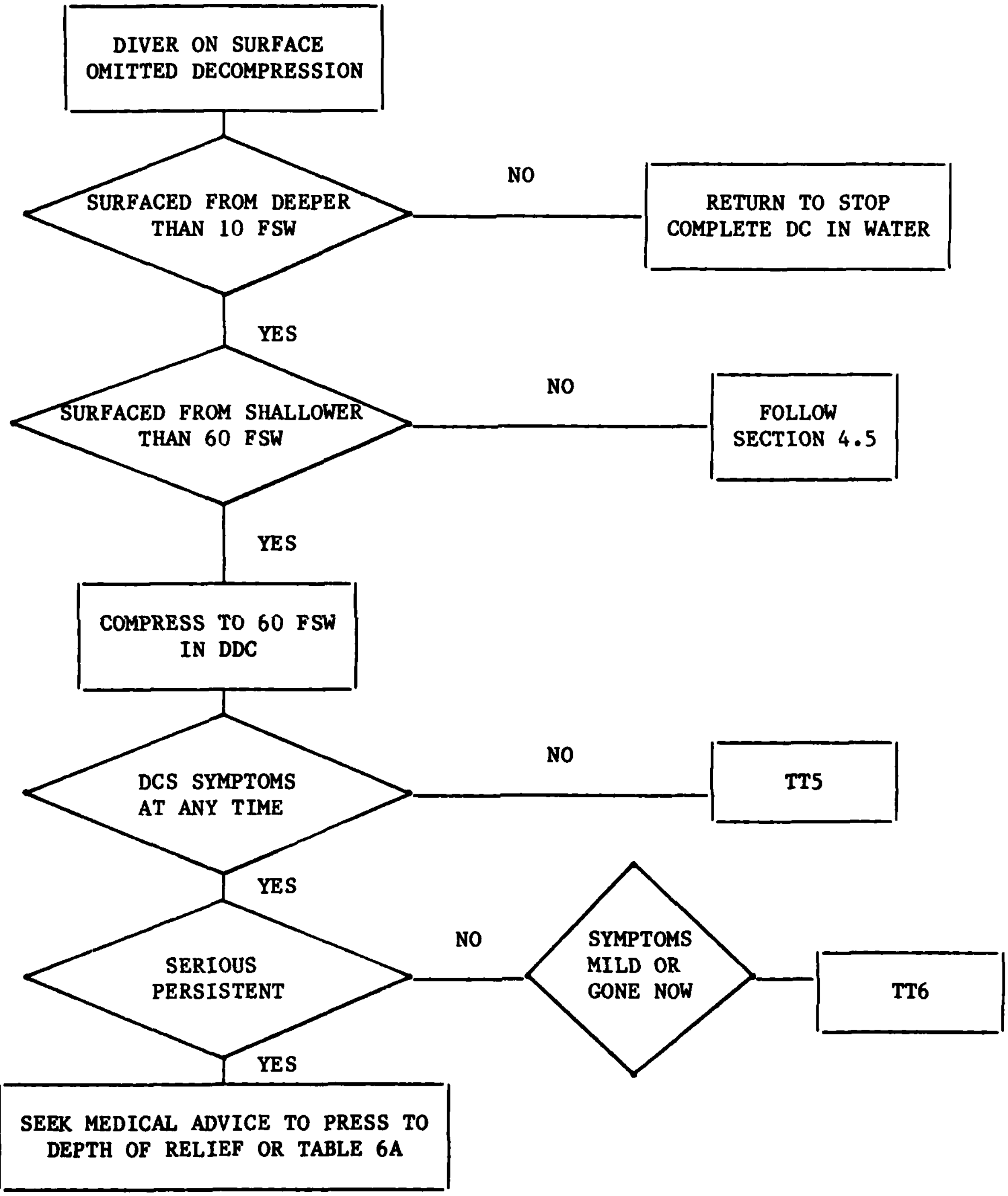
4.2 UBA FAILURE: ACTION FLOW DIAGRAM



4.3 DECOMPRESSION SICKNESS



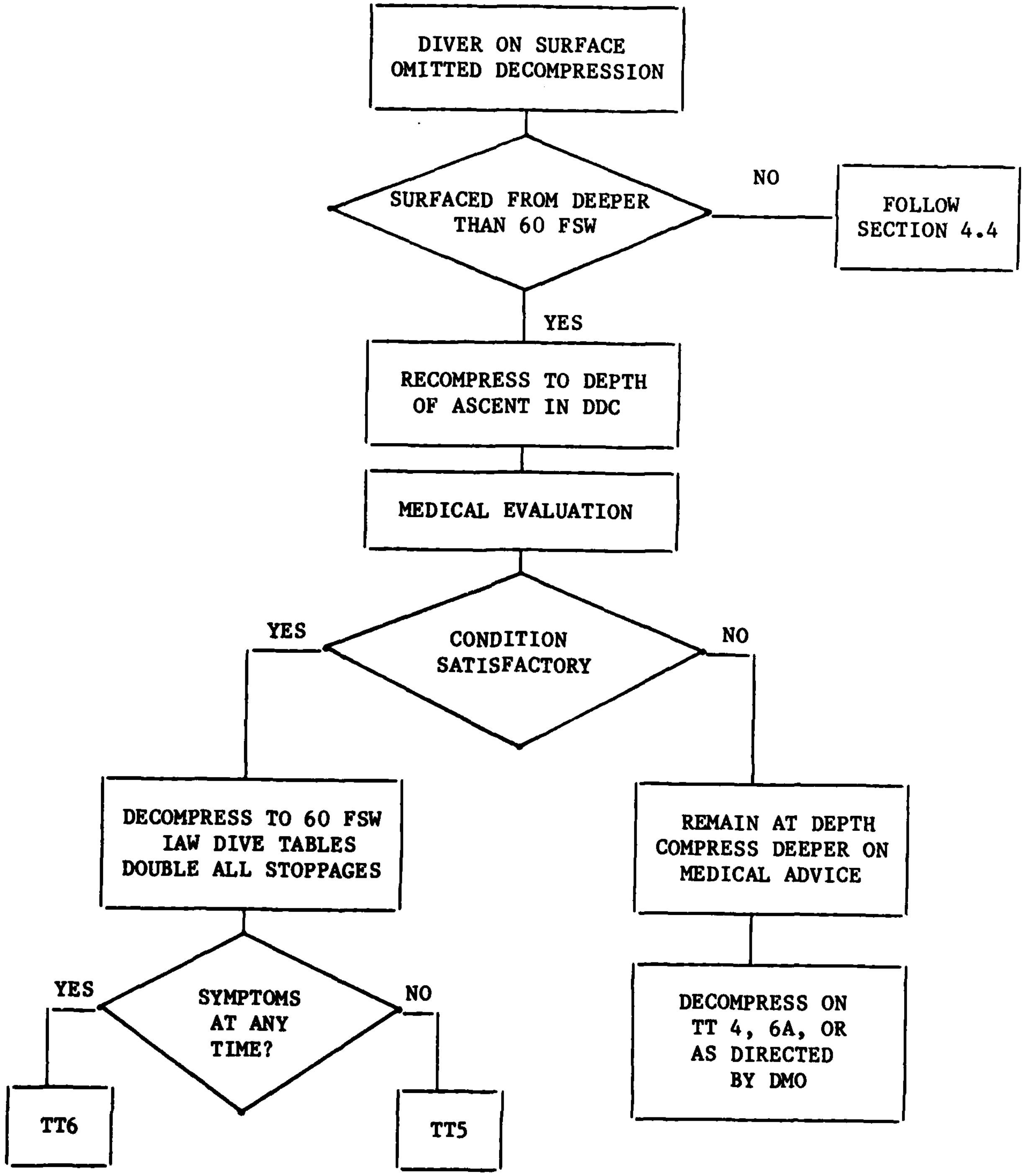
4.4 DIVER UNCONTROLLED SURFACING: OMITTED DECOMPRESSION; SURFACING FROM SHALLOWER THAN 60 FSW



NOTES: 1. Decompression symptoms reported after surfacing are to be treated in accordance with the U.S. Navy Diving Manual.

2. If two divers are affected, treat both as for the worst case.

4.5 DIVER UNCONTROLLED SURFACING: OMITTED DECOMPRESSION; SURFACING FROM DEEPER THAN 60 FSW



NOTES: 1. Decompression symptoms reported after surfacing are to be treated in accordance with the U.S. Navy Diving Manual.

2. If two divers are affected, treat both as for the worst case.

APPENDIX A

PART III

0.7 ATA CONSTANT PARTIAL PRESSURE OF OXYGEN IN HELIUM DECOMPRESSION TABLES

1. These tables are designed to be used with a MK 16 UBA with a set point of 0.7 ATA or greater and a helium diluent.

2. When selecting the proper decompression tables, all dives done within the past 12 hours must be considered. The following rules apply for the various situations which may occur:

a. The last dive was 12 hours or more ago.

Select the table for the maximum depth attained and the total bottom time of the current dive.

b. All dives within the past 12 hours were from these tables.

Add the bottom time of the current dive to the sum of the bottom time for all dives within the past 12 hours to get the adjusted bottom time. Use the maximum depth attained within the past 12 hours and the adjusted bottom time to select the appropriate table.

c. All dives during the past 12 hours were from the Navy Standard Air Tables.

Add the standard air residual nitrogen time for the actual depth of the current dive to the total bottom time of the current dive to get the adjusted total bottom time. Use the maximum depth of the current dive and the adjusted total bottom time to select the appropriate table.

d. Dives within the past 12 hours consisted of dives from more than one of the various tables in the Diving Manual or from tables other than these or the standard air tables.

Use the procedure in paragraph b. above.

3. If an air dive is planned following using these tables, an air repetitive group for use with future air dives may be computed as follows:

Add the bottom times of all dives done within 12 hours of surfacing from the final dive from these tables to get an adjusted bottom time. Find the air table with the maximum depth attained during the past 12 hours and the adjusted bottom time. The repetitive group from this air table may be used to compute the repetitive group at the end of the surface interval for subsequent air dives.

9:05 AM MON., 22 AUG., 1983 TBLP7

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(HVAL13- HELIUM)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN .83 SDR	20 MIN .71 SDR	40 MIN .83 SDR	80 MIN .83 SDR	120 MIN .83 SDR
10 FSW	120.000	98.000	82.000	68.000	56.000	50.000
20 FSW	132.000	110.000	94.000	80.000	68.000	62.000
30 FSW	144.000	122.000	106.000	92.000	80.000	74.000
40 FSW	156.000	134.000	118.000	104.000	92.000	86.000
50 FSW	168.000	146.000	130.000	116.000	104.000	98.000
60 FSW	180.000	158.000	142.000	128.000	116.000	110.000
70 FSW	192.000	170.000	154.000	140.000	128.000	122.000
80 FSW	204.000	182.000	166.000	152.000	140.000	134.000
90 FSW	216.000	194.000	178.000	164.000	152.000	146.000
100 FSW	228.000	206.000	190.000	176.000	164.000	158.000
110 FSW	240.000	218.000	202.000	188.000	176.000	170.000
120 FSW	252.000	230.000	214.000	200.000	188.000	182.000
130 FSW	264.000	242.000	226.000	212.000	200.000	194.000
140 FSW	276.000	254.000	238.000	224.000	212.000	206.000
150 FSW	288.000	266.000	250.000	236.000	224.000	218.000
160 FSW	300.000	278.000	262.000	248.000	236.000	230.000
170 FSW	312.000	290.000	274.000	260.000	248.000	242.000
180 FSW	324.000	302.000	286.000	272.000	260.000	254.000
190 FSW	336.000	314.000	298.000	284.000	272.000	266.000
200 FSW	348.000	326.000	310.000	296.000	284.000	278.000
210 FSW	360.000	338.000	322.000	308.000	296.000	290.000
220 FSW	372.000	350.000	334.000	320.000	308.000	302.000
230 FSW	384.000	362.000	346.000	332.000	320.000	314.000
240 FSW	396.000	374.000	358.000	344.000	332.000	326.000
250 FSW	408.000	386.000	370.000	356.000	344.000	338.000
260 FSW	420.000	398.000	382.000	368.000	356.000	350.000
270 FSW	432.000	410.000	394.000	380.000	368.000	362.000
280 FSW	444.000	422.000	406.000	392.000	380.000	374.000
290 FSW	456.000	434.000	418.000	404.000	392.000	386.000
300 FSW	468.000	446.000	430.000	416.000	404.000	398.000

BLOOD PARAMETERS

(PRESSURE IN FSW; 33 FSW=1 ATA)

PACO2	PH2O	PVCO2	PVO2	AMBAO2
1.50	0.00	2.30	2.00	0.00

2:22 PM MON., 6 JUNE, 1983 TBLP7 HVAL13 (FEET)

.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTA ASCN TIME (M:S
40	365	0:40															0	0:4
50	242	0:50															0	0:5
50	250	0:40															4	4:5
50	260	0:40															9	9:5
50	270	0:40															13	13:5
50	280	0:40															17	17:5
50	290	0:40															21	21:5
50	300	0:40															25	25:5
50	310	0:40															28	28:5
50	320	0:40															31	31:5
50	330	0:40															34	34:5
50	340	0:40															37	37:5
50	350	0:40															40	40:5
50	360	0:40															43	43:5
50	370	0:40															45	45:5
60	146	1:00															0	1:0
60	150	0:50															3	4:0
60	160	0:50															10	11:0
60	170	0:50															20	21:0
60	180	0:50															29	30:00
60	190	0:50															38	39:00
60	200	0:50															47	48:00
60	210	0:50															55	56:00
60	220	0:50															62	63:00
60	230	0:50															69	70:00

9:05 AM MON., 22 AUG., 1983 TBLP7 HVAL13 (FEET)

.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	DECOMPRESSION STOPS (FSW) STOP TIMES (MIN) 150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
40	365	0:40															0	0:40
50	242	0:50															0	0:50
50	250	0:40															4	4:50
50	260	0:40															9	9:50
50	270	0:40															13	13:50
50	280	0:40															17	17:50
50	290	0:40															21	21:50
50	300	0:40															25	25:50
50	310	0:40															28	28:50
50	320	0:40															31	31:50
50	330	0:40															34	34:50
50	340	0:40															37	37:50
50	350	0:40															40	40:50
50	360	0:40															43	43:50
50	370	0:40															45	45:50
60	146	1:00															0	1:00
60	150	0:50															3	4:00
60	160	0:50															10	11:00
60	170	0:50															20	21:00
60	180	0:50															29	30:00
60	190	0:50															38	39:00
60	200	0:50															47	48:00
60	210	0:50															55	56:00
60	220	0:50															62	63:00
60	230	0:50															69	70:00

9:05 AM MON., 22 AUG., 1983 TBLP7 HVAL13 (FEET)

.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DECOMPRESSION STOPS (FSW)
STOP TIMES (MIN)

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
60	240	0:50															76	77:00
60	250	0:50															82	83:00
60	260	0:50															88	89:00
60	270	0:50															94	95:00
60	280	0:50															99	100:00
60	290	0:50															104	105:00
60	300	0:50															109	110:00
60	310	0:50															113	114:00
60	320	0:50															118	119:00
60	330	0:50															122	123:00
60	340	0:40														2	123	126:00
60	350	0:40														6	123	130:00
60	360	0:40														9	123	133:00
60	370	0:40														12	124	137:00

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70	96	1:10															0	1:10
70	100	1:00															2	3:10
70	110	1:00															10	11:10
70	120	1:00															22	23:10
70	130	1:00															33	34:10
70	140	1:00															45	46:10
70	150	1:00															58	59:10
70	160	1:00															72	73:10
70	170	1:00															84	85:10
70	180	1:00															95	96:10
70	190	1:00															106	107:10

9:05 AM MON., 22 AUG., 1983 TBLP7 HVAL13 (FEET)

.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	DECOMPRESSION STOPS (FSW) STOP TIMES (MIN) 150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
70	200	0:50														6	111	118:10
70	210	0:50														11	116	128:10
70	220	0:50														16	120	137:10
70	230	0:50														21	124	146:10
70	240	0:50														30	123	154:10
70	250	0:50														37	124	162:10
80	67	1:20															0	1:20
80	70	1:10															4	5:20
80	80	1:10															14	15:20
80	90	1:10															23	24:20
80	100	1:10															37	38:20
80	110	1:10															52	53:20
80	120	1:00														1	65	67:20
80	130	1:00														5	79	85:20
80	140	1:00														9	92	102:20
80	150	1:00														20	98	119:20
80	160	1:00														30	103	134:20
80	170	1:00														39	109	149:20
90	44	1:30															0	1:30
90	50	1:20															5	6:30
90	60	1:20															13	14:30
90	70	1:20															28	29:30
90	80	1:20															40	41:30
90	90	1:10														9	48	58:30
90	100	1:10														17	59	77:30

9:05 AM MON., 22 AUG., 1983 TBLP7 HVAL13 (FEET)

.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	DECOMPRESSION STOPS (FSW) STOP TIMES (MIN) 150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
90	110	1:10														24	70	95:30
90	120	1:10														31	86	118:30
90	130	1:10														43	95	139:30
90	140	1:10														57	101	159:30
100	33	1:40															0	1:40
100	35	1:30															1	2:40
100	40	1:30															9	10:40
100	50	1:30															22	23:40
100	60	1:20														7	28	36:40
100	70	1:20														13	38	52:40
100	80	1:20														24	46	71:40
100	90	1:20														36	58	95:40
100	100	1:10													4	41	71	117:40
100	110	1:10													12	42	88	143:40
100	120	1:10													19	53	96	169:40
100	130	1:10													25	64	103	193:40
110	23	1:50															0	1:50
110	25	1:40															2	3:50
110	30	1:40															6	7:50
110	35	1:40															15	16:50
110	40	1:30														1	23	25:50
110	50	1:30														14	24	39:50
110	60	1:30														24	33	58:50
110	70	1:20													7	27	41	76:50
110	80	1:20													12	37	55	105:50

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.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	DECOMPRESSION STOPS (FSW) STOP TIMES (MIN) 150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
110	90	1:20													21	41	69	132:50
110	100	1:20													32	41	87	161:50
110	110	1:20													41	54	95	191:50
110	120	1:10												8	41	67	103	220:50
120	19	2:00															0	2:00
120	20	1:50															2	4:00
120	25	1:50															8	10:00
120	30	1:40														3	14	19:00
120	35	1:40														6	22	30:00
120	40	1:40														15	23	40:00
120	50	1:30													6	24	25	57:00
120	60	1:30													17	24	38	81:00
120	70	1:20												1	24	33	48	108:00
120	80	1:20												7	27	41	63	140:00
120	90	1:20												11	37	41	81	172:00
120	100	1:20												19	41	52	92	206:00
120	110	1:20												29	41	67	101	240:00
130	16	2:10															0	2:10
130	20	2:00															8	10:10
130	25	1:50														5	10	17:10
130	30	1:50														10	19	31:10
130	35	1:40													4	14	24	44:10
130	40	1:40													6	23	24	55:10
130	50	1:40													22	24	28	76:10
130	60	1:30												11	23	25	41	102:10

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.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	DECOMPRESSION STOPS (FSW) STOP TIMES (MIN) 150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
130	70	1:30												19	24	39	54	138:10
130	80	1:20											1	24	34	41	73	175:10
130	90	1:20											6	28	41	47	91	215:10
130	100	1:20											9	38	41	64	99	253:10
140	13	2:20															0	2:20
140	15	2:10															2	4:20
140	20	2:00														4	10	16:20
140	25	1:50													1	11	13	27:20
140	30	1:50													7	11	24	44:20
140	35	1:40												1	10	21	24	58:20
140	40	1:40												4	16	24	24	70:20
140	50	1:40												15	23	24	32	96:20
140	60	1:30											4	24	24	29	45	128:20
140	70	1:30											13	24	27	41	68	175:20
140	80	1:30											20	24	40	41	91	218:20
150	11	2:30															0	2:30
150	15	2:10														1	6	9:30
150	20	2:10														10	10	22:30
150	25	2:00													8	10	18	38:30
150	30	1:50												4	10	16	24	56:30
150	35	1:50												9	13	23	24	71:30
150	40	1:40											2	10	22	24	24	84:30
150	45	1:40											4	17	24	24	27	98:30
150	50	1:40											7	24	24	23	35	115:30
150	55	1:40											15	23	24	26	46	136:30

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.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
			DECOMPRESSION STOPS (FSW) STOP TIMES (MIN)															
150	60	1:40											21	24	24	34	59	164:30
150	70	1:30										7	24	24	33	41	85	216:30
150	80	1:30										15	23	31	41	47	105	264:30
********																		
155	10	2:35															0	2:35
155	15	2:15														2	8	12:35
155	20	2:05													2	11	10	25:35
155	25	1:55												1	10	11	19	43:35
155	30	1:55												8	10	18	24	62:35
155	35	1:45											2	11	15	24	24	78:35
155	40	1:45											6	12	24	24	23	91:35
155	45	1:45											8	21	24	24	28	107:35
155	50	1:45											15	24	24	23	37	125:35
155	55	1:35										1	22	24	24	27	54	154:35
155	60	1:35										6	24	24	23	37	69	185:35
155	70	1:35										16	24	24	36	41	95	238:35
155	80	1:35										24	24	33	41	52	110	286:35
********																		
160	9	2:40															0	2:40
160	10	2:30															1	3:40
160	15	2:20														4	8	14:40
160	20	2:10													5	11	10	28:40
160	25	2:00												5	10	10	22	49:40
160	30	1:50											1	10	11	21	23	68:40
160	35	1:50											6	10	19	24	24	85:40
160	40	1:50											10	15	24	24	24	99:40
160	45	1:40										2	11	24	24	24	29	116:40

9:05 AM MON., 22 AUG., 1983 TBLP7 HVAL13 (FEET)

.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	DECOMPRESSION STOPS (FSW) STOP TIMES (MIN) 150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
160	50	1:40										4	19	24	24	23	46	142:40
160	55	1:40										7	24	24	24	30	63	174:40
160	60	1:40										14	24	24	24	39	78	205:40
160	70	1:30									1	24	24	24	38	41	105	259:40
165	9	2:45															0	2:45
165	10	2:35															2	4:45
165	15	2:15													1	4	10	17:45
165	20	2:05												1	7	10	11	31:45
165	25	2:05												8	10	11	23	54:45
165	30	1:55											5	10	10	24	24	75:45
165	35	1:55											10	10	22	24	24	92:45
165	40	1:45										3	10	19	24	24	24	106:45
165	45	1:45										6	15	24	23	24	32	126:45
165	50	1:45										8	23	24	24	23	56	160:45
165	55	1:45										16	24	23	24	32	74	195:45
165	60	1:45										23	24	24	24	40	88	225:45
165	70	1:35									10	24	24	24	41	43	115	283:45
170	8	2:50															0	2:50
170	10	2:40															3	5:50
170	15	2:20													3	4	11	20:50
170	20	2:10												2	9	10	12	35:50
170	25	2:00											1	10	10	13	24	60:50
170	30	2:00											9	10	12	24	24	81:50
170	35	1:50										4	10	11	24	23	24	98:50
170	40	1:50										7	10	23	23	24	24	113:50

9:05 AM MON., 22 AUG., 1983 TBLP7 HVAL13 (FEET)

.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	DECOMPRESSION STOPS (FSW) STOP TIMES (MIN) 150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
170	45	1:50										10	18	24	24	24	41	143:50
170	50	1:40									2	13	24	24	24	24	67	180:50
170	55	1:40									3	21	24	24	24	33	84	215:50
170	60	1:40									8	24	23	24	26	41	99	247:50
170	70	1:40									19	24	24	27	41	47	122	306:50
175	8	2:55															0	2:55
175	10	2:45															4	6:55
175	15	2:25													4	6	10	22:55
175	20	2:15												4	10	10	14	40:55
175	25	2:05											5	10	10	15	23	65:55
175	30	1:55										2	10	10	15	24	24	87:55
175	35	1:55										7	10	15	23	24	24	105:55
175	40	1:45									1	10	12	24	24	24	25	122:55
175	45	1:45									4	10	22	24	24	24	52	162:55
175	50	1:45									6	17	24	24	24	25	79	201:55
175	55	1:45									8	24	24	24	24	35	94	235:55
175	60	1:45									16	24	24	24	28	41	109	268:55
180	7	3:00															0	3:00
180	10	2:40														1	4	8:00
180	15	2:20												1	4	7	11	26:00
180	20	2:10											1	6	10	10	16	46:00
180	25	2:10											8	10	10	17	24	72:00
180	30	2:00										6	10	10	17	24	24	94:00
180	35	1:50									1	10	10	17	24	24	24	113:00
180	40	1:50									5	10	15	24	24	24	35	140:00

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.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	DECOMPRESSION STOPS (FSW) STOP TIMES (MIN) 150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
180	45	1:50									8	12	24	24	23	24	64	182:00
180	50	1:50									10	21	24	24	24	27	88	221:00
180	55	1:40								1	16	24	23	24	24	38	104	257:00
180	60	1:40								2	23	24	24	23	31	41	121	292:00
185	7	3:05															0	3:05
185	10	2:45														3	4	10:05
185	15	2:25												3	4	8	10	28:05
185	20	2:15											3	7	10	10	17	50:05
185	25	2:05										1	10	10	10	20	23	77:05
185	30	2:05										9	10	10	21	23	24	100:05
185	35	1:55									5	10	10	20	24	24	24	120:05
185	40	1:55									9	10	19	23	24	24	45	157:05
185	45	1:45								2	10	15	24	24	24	24	75	201:05
185	50	1:45								4	11	24	24	24	24	29	98	241:05
185	55	1:45								5	20	24	24	24	24	39	116	279:05
185	60	1:45								10	23	24	24	24	33	50	123	314:05
190	7	3:10															0	3:10
190	10	2:50														4	4	11:10
190	15	2:30												4	4	9	10	30:10
190	20	2:20											4	9	10	10	19	55:10
190	25	2:10										4	11	10	10	21	24	83:10
190	30	2:00									3	10	10	10	23	24	23	106:10
190	35	2:00									8	11	10	23	24	23	26	128:10
190	40	1:50								3	10	10	22	24	23	24	57	176:10
190	45	1:50								6	10	19	24	24	24	24	87	221:10

.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
			DECOMPRESSION STOPS (FSW) STOP TIMES (MIN)															
190	50	1:50								8	15	24	24	24	24	30	110	262:10
190	55	1:50								10	23	24	24	24	24	45	123	300:10
190	60	1:50								18	24	24	24	24	34	63	123	337:10
195	7	3:15															0	3:15
195	10	2:45													1	4	4	12:15
195	15	2:25											1	4	5	10	10	33:15
195	20	2:15										2	4	10	10	10	21	60:15
195	25	2:15										8	10	10	10	23	24	88:15
195	30	2:05									6	10	10	12	24	24	24	113:15
195	35	1:55								2	10	10	13	23	24	24	35	144:15
195	40	1:55								6	11	11	24	24	24	24	67	194:15
195	45	1:55								10	10	23	24	23	24	24	99	240:15
195	50	1:45							2	10	19	24	24	24	24	32	121	283:15
195	55	1:45							3	15	24	24	23	24	26	59	123	324:15
195	60	1:45							4	23	24	23	24	24	37	75	123	360:15
200	6	3:20															0	3:20
200	10	2:50													2	4	4	13:20
200	15	2:30											3	4	5	10	10	35:20
200	20	2:20										3	6	10	10	10	22	64:20
200	25	2:10									2	9	10	10	12	24	24	94:20
200	30	2:10									10	10	10	14	24	24	24	119:20
200	35	2:00								6	10	10	15	24	24	24	45	161:20
200	40	2:00								10	10	15	24	24	24	24	78	212:20
200	45	1:50							3	10	14	23	24	24	24	24	111	260:20
200	50	1:50							6	10	23	24	24	24	24	43	123	304:20

9:05 AM MON., 22 AUG., 1983 TBLP7 HVAL13 (FEET)

.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
			DECOMPRESSION STOPS (FSW) STOP TIMES (MIN)															
200	55	1:50							7	19	24	24	24	24	28	70	123	346:20
200	60	1:50							11	24	24	24	24	24	39	87	123	383:20

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205	6	3:25															0	3:25
205	10	2:55													3	4	4	14:25
205	15	2:35											4	4	7	10	10	38:25
205	20	2:15									1	4	7	10	10	10	24	69:25
205	25	2:15									4	10	10	11	14	23	24	99:25
205	30	2:05								3	10	10	10	17	24	24	24	125:25
205	35	2:05								10	10	10	18	24	24	24	55	178:25
205	40	1:55							4	10	10	19	23	24	24	24	91	232:25
205	45	1:55							7	10	17	24	24	24	24	25	122	280:25
205	50	1:55							10	13	24	24	24	24	24	57	123	326:25
205	55	1:45						1	10	23	24	24	24	24	30	81	123	367:25
205	60	1:45						2	18	24	24	23	24	25	41	100	123	407:25

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210	6	3:30															0	3:30
210	10	3:00													4	4	5	16:30
210	15	2:30										1	4	5	7	10	10	40:30
210	20	2:20									2	4	9	10	10	12	24	74:30
210	25	2:10								1	7	10	10	10	16	24	24	105:30
210	30	2:10								7	10	10	10	19	24	24	29	136:30
210	35	2:00							3	10	10	11	21	24	23	24	67	196:30
210	40	2:00							8	10	10	22	24	23	24	24	103	251:30
210	45	1:50						1	10	10	21	24	24	23	24	38	123	301:30
210	50	1:50						4	10	17	24	24	24	24	24	72	123	349:30
210	55	1:50						5	14	24	24	23	24	24	32	95	123	391:30

9:05 AM MON., 22 AUG., 1983 TBLP7 HVAL13 (FEET)

.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
								DECOMPRESSION STOPS (FSW) STOP TIMES (MIN)										
210	60	1:50						6	22	24	24	24	24	27	41	113	123	431:30
215	6	3:35															0	3:35
215	10	2:55												1	4	4	6	18:35
215	15	2:35										3	4	4	9	10	10	43:35
215	20	2:25									4	4	10	10	10	13	24	78:35
215	25	2:15								2	9	10	10	10	18	24	24	110:35
215	30	2:15								10	10	10	11	22	23	24	38	151:35
215	35	2:05							7	10	10	11	23	24	24	24	77	213:35
215	40	1:55						2	10	10	11	24	24	24	24	23	115	270:35
215	45	1:55						5	10	11	23	24	24	24	24	51	123	322:35
215	50	1:55						8	10	21	24	24	24	24	24	85	124	371:35
220	6	3:40															0	3:40
220	10	3:00												2	4	4	6	19:40
220	15	2:40										4	4	4	10	10	10	45:40
220	20	2:20								1	4	6	10	10	10	15	24	83:40
220	25	2:20								4	10	10	10	10	21	24	24	116:40
220	30	2:10							4	10	10	10	11	24	23	24	49	168:40
220	35	2:00						1	10	10	10	13	24	24	24	24	89	232:40
220	40	2:00						6	10	10	14	24	24	24	24	28	123	290:40
220	45	2:00						9	10	14	24	24	24	24	23	66	123	344:40
220	50	1:50					2	10	11	24	24	24	24	24	24	99	123	392:40
225	5	3:45															0	3:45
225	10	3:05												3	4	4	7	21:45
225	15	2:35									1	4	5	4	11	10	10	48:45
225	20	2:25								3	4	7	10	10	10	17	24	88:45

9:05 AM MON., 22 AUG., 1983 TBLP7 HVAL13 (FEET)

.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
			DECOMPRESSION STOPS (FSW) STOP TIMES (MIN)															
225	25	2:15							2	5	10	11	10	10	22	24	24	121:45
225	30	2:15							7	10	10	11	13	24	24	23	59	184:45
225	35	2:05						4	10	11	10	16	24	24	24	23	101	250:45
225	40	2:05						9	11	10	17	24	24	24	24	40	123	309:45
225	45	1:55					3	10	10	18	24	24	23	24	24	80	123	366:45
225	50	1:55					6	10	15	24	24	24	24	24	25	114	123	416:45
230	5	3:50															0	3:50
230	10	3:10												4	4	4	8	23:50
230	15	2:40									3	4	4	6	10	10	12	52:50
230	20	2:30								4	4	8	11	10	10	18	24	92:50
230	25	2:20							3	8	10	10	10	11	24	24	25	128:50
230	30	2:10						1	10	10	10	10	16	24	24	24	69	201:50
230	35	2:10						8	10	10	10	20	24	23	24	24	112	268:50
230	40	2:00					3	10	10	11	21	24	23	24	24	54	123	330:50
230	45	2:00					7	10	10	21	24	24	24	24	24	92	123	386:50
230	50	2:00					10	10	19	24	24	24	24	24	34	120	123	439:50
235	5	3:55															0	3:55
235	10	3:05											1	4	4	4	9	25:55
235	15	2:45									4	4	4	7	10	11	13	56:55
235	20	2:25							2	4	4	9	10	11	10	20	24	97:55
235	25	2:15						1	4	9	10	10	10	13	24	24	34	142:55
235	30	2:15						4	10	10	11	10	18	24	24	24	80	218:55
235	35	2:05					2	10	10	10	10	22	24	24	24	26	121	286:55
235	40	2:05					7	10	10	11	24	24	24	23	24	68	123	351:55
235	45	1:55				1	10	10	11	24	24	24	24	23	24	107	123	408:55

9:05 AM MON., 22 AUG., 1983 TBLP7 HVAL13 (FEET)

.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	DECOMPRESSION STOPS (FSW) STOP TIMES (MIN) 150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
235	50	1:55				3	11	10	23	24	24	24	24	24	46	123	123	462:55
240	5	4:00															0	4:00
240	10	3:10											2	4	4	5	9	28:00
240	15	2:40								1	4	5	4	8	10	10	14	60:00
240	20	2:30							3	4	5	10	10	11	10	22	23	102:00
240	25	2:20						2	5	10	10	10	10	16	23	24	43	157:00
240	30	2:20						8	10	10	10	10	21	24	24	24	90	235:00
240	35	2:10					5	10	11	10	11	24	24	24	24	36	123	306:00
240	40	2:00				1	10	10	10	14	24	24	24	24	23	81	123	372:00
240	45	2:00				5	10	10	15	24	23	24	24	24	29	117	123	432:00
245	5	4:05															0	4:05
245	10	3:15											3	4	4	5	9	29:05
245	15	2:45								3	4	4	4	9	10	10	16	64:05
245	20	2:25						1	4	4	6	10	10	10	11	23	24	107:05
245	25	2:25						4	6	10	10	11	10	17	24	24	52	172:05
245	30	2:15					1	10	10	10	11	10	23	24	24	24	101	252:05
245	35	2:15					9	10	10	10	15	24	24	23	24	50	123	326:05
245	40	2:05				5	10	10	10	17	24	24	24	24	24	94	123	393:05
245	45	2:05				9	10	10	18	24	24	24	24	24	37	124	123	455:05
250	5	4:10															0	4:10
250	10	3:20											4	4	5	4	10	31:10
250	15	2:50								4	4	4	4	11	10	10	17	68:10
250	20	2:30						2	4	4	8	10	10	10	12	24	24	112:10
250	25	2:20					1	5	8	10	10	10	10	19	24	24	62	187:10
250	30	2:20					5	10	10	10	10	12	24	24	24	24	112	269:10

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.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
			DECOMPRESSION STOPS (FSW) STOP TIMES (MIN)															
250	35	2:10				3	10	10	10	10	18	23	24	24	24	63	123	346:10
250	40	2:10				9	10	10	10	21	23	24	24	24	24	108	123	414:10
250	45	2:00			3	10	10	10	22	24	24	24	23	24	54	123	123	478:10
********																		
255	5	4:15															0	4:15
255	10	3:15										1	4	4	5	5	10	33:15
255	15	2:45							1	4	4	5	5	10	10	10	18	71:15
255	20	2:35						4	4	4	9	10	10	10	13	24	24	116:15
255	25	2:25					3	4	10	10	10	10	10	22	24	23	72	202:15
255	30	2:15				1	7	10	10	11	10	15	23	24	24	29	119	287:15
255	35	2:15				6	11	10	10	10	20	24	24	24	24	75	124	366:15
255	40	2:05			2	10	10	11	10	24	24	23	24	24	29	117	123	435:15
255	45	2:05			6	11	10	12	24	23	24	24	24	24	68	123	123	500:15
********																		
260	5	4:10															1	5:20
260	10	3:20										2	4	5	4	6	10	35:20
260	15	2:50							3	4	4	4	6	10	11	10	19	75:20
260	20	2:30					1	4	4	5	10	10	10	10	15	24	27	124:20
260	25	2:20				1	4	5	10	10	10	10	10	24	24	24	81	217:20
260	30	2:20				2	10	10	10	10	10	18	23	24	24	37	123	305:20
260	35	2:20				10	10	10	10	11	23	24	24	23	24	88	123	384:20
260	40	2:10			6	10	10	10	14	24	24	24	23	24	38	123	123	457:20
260	45	2:10			10	11	10	15	24	24	24	24	24	23	83	123	123	522:20
********																		
265	5	4:15															1	5:25
265	10	3:25										3	4	5	4	6	11	37:25
265	15	2:55							4	4	4	4	8	10	10	10	21	79:25
265	20	2:35					3	4	4	6	10	10	10	10	17	23	36	137:25

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.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	DECOMPRESSION STOPS (FSW) STOP TIMES (MIN) 150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
265	25	2:25				2	4	7	10	10	11	10	12	24	23	24	93	234:25
265	30	2:25				5	10	10	10	11	10	20	23	24	24	48	124	323:25
265	35	2:15			4	10	10	10	10	13	23	24	24	24	24	101	123	404:25
265	40	2:15			10	10	10	10	17	24	24	24	24	23	53	123	123	479:25
265	45	2:05		4	10	10	11	19	24	24	23	24	24	24	99	123	123	546:25
270	5	4:20															2	6:30
270	10	3:30										4	5	4	4	7	10	38:30
270	15	2:50						1	4	4	4	5	8	10	10	10	22	82:30
270	20	2:40					4	4	4	7	11	10	10	10	18	24	43	149:30
270	25	2:30				4	4	8	11	10	10	10	14	24	24	24	103	250:30
270	30	2:20			1	8	10	10	10	10	10	23	24	23	24	61	123	341:30
270	35	2:20			7	11	10	10	10	15	24	24	24	24	27	111	123	424:30
270	40	2:10		4	10	10	10	10	20	24	24	24	24	24	66	123	124	501:30
270	45	2:10		8	10	10	11	22	24	24	24	24	24	27	110	124	123	569:30
275	5	4:25															2	6:35
275	10	3:25									1	4	5	4	4	8	10	40:35
275	15	2:55						3	4	4	4	4	9	11	10	10	24	87:35
275	20	2:35				2	4	4	4	8	10	11	10	10	20	24	51	162:35
275	25	2:25			1	4	5	10	10	10	10	10	16	24	24	26	111	265:35
275	30	2:25			3	9	10	10	10	11	11	24	24	23	24	73	123	359:35
275	35	2:15		1	10	10	10	10	11	18	24	24	23	24	35	118	123	445:35
275	40	2:15		8	10	10	10	10	23	24	24	24	24	24	81	123	123	522:35
280	5	4:30															3	7:40
280	10	3:30									2	5	4	4	4	9	10	42:40
280	15	3:00						4	4	4	4	5	10	10	10	11	24	90:40

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.70 ATA FIXED PO2 IN HELIUM DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	DECOMPRESSION STOPS (FSW) STOP TIMES (MIN) 150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
295	25	2:35		3	5	4	10	11	10	10	10	11	24	24	23	58	123	330:55
295	30	2:25	1	5	10	10	10	10	10	11	21	24	24	24	36	110	123	433:55
295	35	2:25	6	10	10	10	10	10	16	24	24	24	24	24	84	123	124	527:55
300	5	4:40														1	4	10:00
300	10	3:40								2	4	5	4	4	6	10	10	50:00
300	15	3:00				1	4	4	4	4	4	9	10	10	11	17	24	107:00
300	20	2:40		1	4	4	4	4	10	10	10	10	10	15	24	24	97	232:00
300	25	2:30	1	4	4	7	10	10	10	10	10	13	24	24	24	70	123	349:00
300	30	2:30	3	6	11	10	10	10	10	10	24	24	24	24	45	115	123	454:00
300	35	2:30	9	11	10	10	10	10	19	24	24	24	24	23	100	123	123	549:00
310	6	4:30												1	3	5	4	18:10
310	10	3:50								4	5	4	4	4	7	10	10	53:10
310	15	3:10				4	4	4	4	4	5	10	10	10	10	21	34	125:10
310	20	2:50		4	4	4	4	6	10	10	10	11	10	19	23	33	107	260:10
320	6	4:40												2	4	4	4	19:20
320	10	3:50							2	4	5	4	4	4	8	10	11	57:20
320	15	3:10			2	4	4	4	4	5	7	10	10	10	10	24	45	144:20
320	20	2:50	3	4	4	4	4	9	10	10	10	10	10	23	24	48	110	288:20

APPENDIX B

TABLES OF TOTAL DIVES ACHIEVED DURING MK 16 PROCEDURE EVALUATION
13 JUNE - 1 JULY 1983

TABLE 7

MARKED SWIMMING

	MAN HOURS	MAN DIVES
DAY	59	67
NIGHT	14	18
TOTAL	73	85

TABLE 8

ATTENDED SWIMMING

	MAN HOURS	MAN DIVES
DAY	37	62
NIGHT	5.5	12
TOTAL	42.5	74

TABLE 9

MK 16 DEPLOYMENT PROCEDURES RECORD OF MARKED SWIMMING OPERATIONS
13 JUNE - 1 JULY 1983

1. ALL MARKED SWIMMING OPERATIONS WERE CONDUCTED USING A JACKSTAY SYSTEM EXCEPT WHEN INDICATED.

DIVE	DIVERS	DEPTH (FSW)	TIME (MIN)	DECOMPRESSION (MIN)	DAY/ NIGHT	SEA STATE	VISIBILITY (FT)	COMMENTS
1	2	40	61		DAY	1	5	N_2O_2
2	2	40	62					N_2O_2
3	2	40	60					N_2O_2
4	2	40	60				0	N_2O_2
5	2	40	57					N_2O_2
6	2	40	59					N_2O_2
7	2	40	30		NIGHT	1	0	N_2O_2
8	2	40	25					N_2O_2
9	2	40	32					N_2O_2
10	2	40	69		DAY	1	5	N_2O_2
11	2	40	65					N_2O_2
12	2	40	72					N_2O_2
13	2	40	38		NIGHT	1	0	N_2O_2
14	2	40	30					N_2O_2
15	2	40	35					N_2O_2
16	2	40	60		DAY	1	10	COMPASS SWIM
17	2	40	62					---- " ----
18	2	40	65					---- " ----
19	2	60	60	5*	DAY	2/3	5	HeO_2

* SIMULATED
** RIG FLOOD

TABLE 9
(continued)

DIVE	DIVERS	DEPTH (FSW)	TIME (MIN)	DECOMPRESSION (MIN)	DAY/ NIGHT	SEA STATE	VISIBILITY (FT)	COMMENTS
20	2	60	57	5*	DAY	2/3	5	HeO_2
21	2	60	48	5*				HeO_2
22	2	60	26	5*				HeO_2
23	2	60	08**					HeO_2
24	2	60	31	5*				HeO_2
25	2	60	27	5*				HeO_2
26	2	60	37	10*	DAY	2	20	HeO_2
27	2	60	46	10*				HeO_2
28	1	60	33	5*	DAY	2	3	HeO_2
29	1	60	29	5*				HeO_2
30	1	60	31	5*				HeO_2
31	1	60	40	5*				HeO_2
32	1	60	47	5*				HeO_2
33	1	60	49	5*				HeO_2
34	2	40	46		NIGHT	1	10	COMPASS SWIM
35	2	40	50					COMPASS SWIM
36	2	60	42	10*	DAY	2/3	5	HeO_2
37	2	60	30	10*				HeO_2
38	2	60	41	10*				HeO_2
39	2	60	24	10*	DAY	2/3	10	HeO_2
40	1	60	15	10*				HeO_2

* SIMULATED
** RIG FLOOD

TABLE 9
(continued)

DIVE	DIVERS	DEPTH (FSW)	TIME (MIN)	DECOMPRESSION (MIN)	DAY/ NIGHT	SEA STATE	VISIBILITY (FT)	COMMENTS
41	2	140	15	5*	DAY	2/3	10	HeO_2
42	2	140	25	5*				HeO_2
43	2	140	20	18	DAY	2	50	HeO_2
44	2	140	19	17				HeO_2
45	2	140	22	27		3		HeO_2
46	2	140	21	30	NIGHT			HeO_2
47	2	160	30	70	DAY	2	40	HeO_2
48	2	160	27	72				HeO_2

* SIMULATED
** RIG FLOOD

TABLE 10

MK 16 DEPLOYMENT PROCEDURES RECORD OF ATTENDED SWIMMING OPERATIONS
13 JUNE - 1 JULY 1983

DIVE	DIVERS	DEPTH (FSW)	TIME (MIN)	DECOMPRESSION (MIN)	DAY/ NIGHT	SEA STATE	VISIBILITY (FT)	COMMENTS
1	2	60	10	5*	DAY	3	15	ALL DIVES HeO_2
2	2	60	10	5*				
3	2	60	11	5*				
4	2	60	7	5*				
5	2	60	10	6*	DAY	3	10	
6	1	60	10	7*				INCORPORATING EMERGENCY
7	2	60	5	5*				PROCEDURE RIG CHANGES
8	2	60	10	3*				
9	2	60	10	3*				
10	2	60	10	4*				
11	2	60	9	2*				
12	2	60	9	4*	DAY	3	10	
13	1	50	10	5*	NIGHT	2	0	INCORPORATING EMERGENCY
14	1	50	17	5*				PROCEDURE RIG CHANGES
15	1	50	14	5*				
16	1	50	17	5*				
17	2	60	10	6*	DAY	2	30	INCORPORATING EMERGENCY
18	2	60	5	7*				PROCEDURE RIG CHANGES
19	2	60	7	2*				

* SIMULATED
** RIG FLOOD

TABLE 10
(continued)

DIVE	DIVERS	DEPTH (FSW)	TIME (MIN)	DECOMPRESSION (MIN)	DAY/ NIGHT	SEA STATE	VISIBILITY (FT)	COMMENTS
20	2	60	4	4*	DAY	2	30	
21	1	60	9	6*				
22	1	40	9	5*	NIGHT	1	10	EMERGENCY PROCEDURE RIG CHANGE
23	1	40	10	6*				
24	1	40	8	7*				
25	1	40	7	5*				
26	2	140	18	17	DAY	2	5	
27	1	140	20	17		2	5	
28	2	160	19	28	DAY	4	70	
29	2	160	15	15		3		
30	2	160	15	15	NIGHT	2		
31	2	185	30	100	DAY	2	60	
32	2	185	20	49		4		
33	2	185	14	28		4		
34	2	185	15	29		4		
35	2	185	10	10	NIGHT	3	5	
36	2	205	30	120	DAY	1	70	
37	2	205	20	75				
38	2	205	20	68				
39	1	205	15	30				
40	1	205	10	14				

* SIMULATED
** RIG FLOOD

TABLE 10
(continued)

DIVE	DIVERS	DEPTH (FSW)	TIME (MIN)	DECOMPRESSION (MIN)	DAY/ NIGHT	SEA STATE	VISIBILITY (FT)	COMMENTS
41	1	205	10	14	DAY	1	70	
42	1	205	6	NO D				
43	1	205	6	NO D				

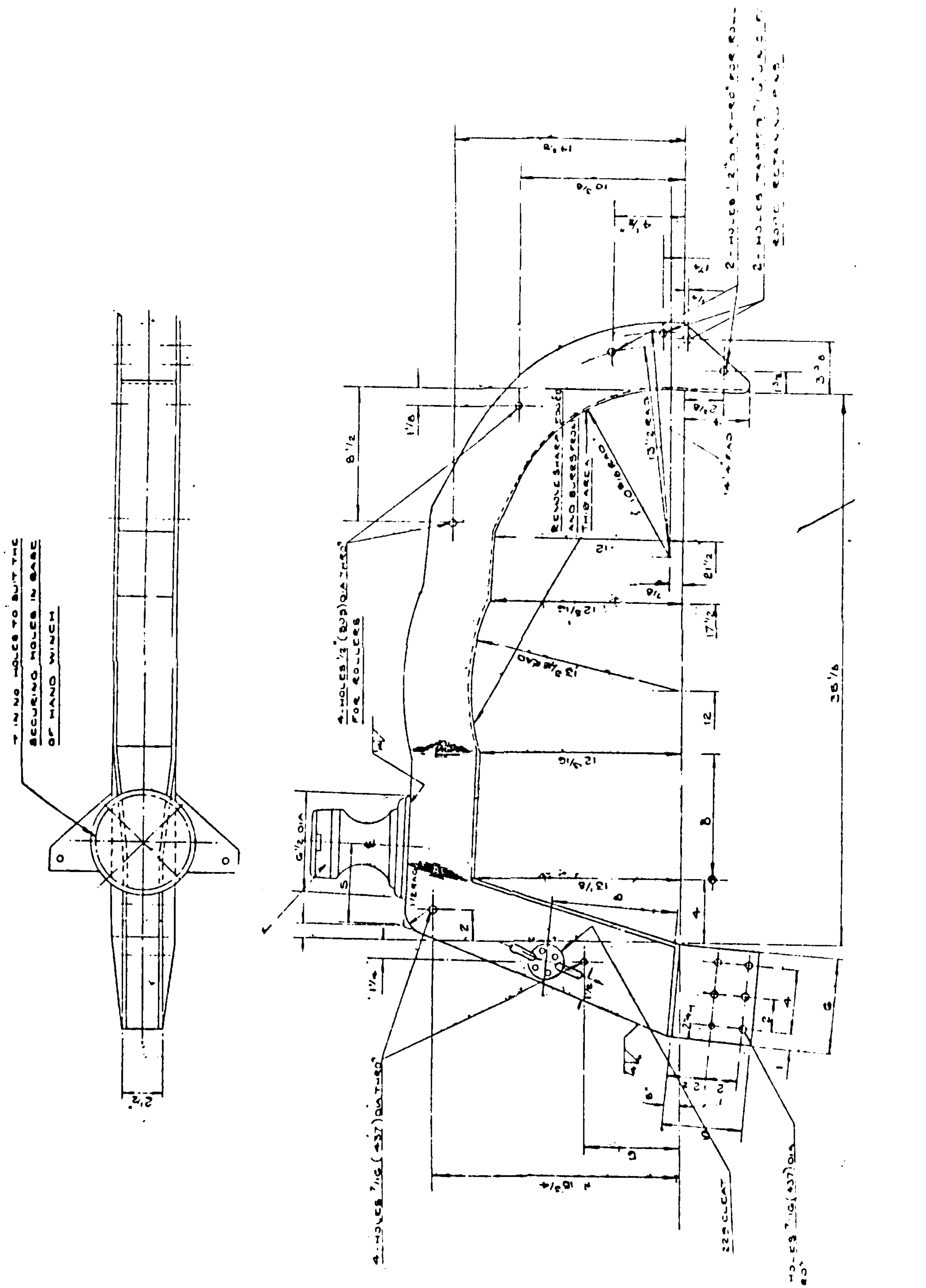
APPENDIX C

TABLE OF MK 15 FAILURES AND DEFECTS
13 JUNE - 1 JULY 1983

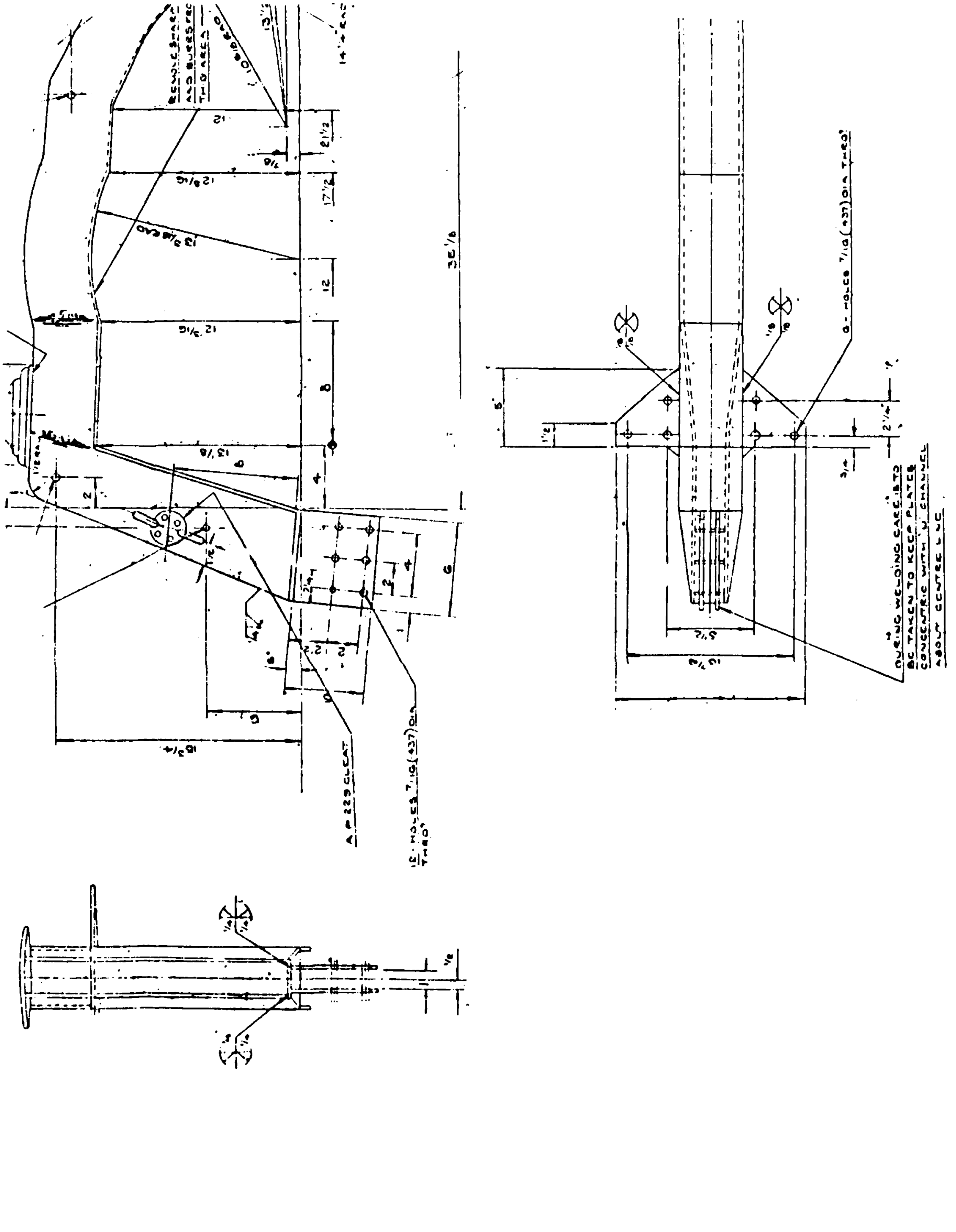
NO.	TOTAL NO.	TYPE	DESCRIPTION	CAUSE
1	14	FAILURE	CUTTING OF BREATHING HOSES AT HOSE COUPLING	ABRASION AND DRY ROT
2	1	FAULT	BATTERY INTERCONNECTION CABLE	NK
3	1	FAILURE	BATTERY (DURING DECOMPRESSION)	NK
4	2	FLOOD OUT	CANISTER AND BREATHING LOOP FLOOD	POSSIBLE OPERATOR ERROR
5	2	FAILURE	DILUENT ADDITION VALVES STUCK OPEN	DIRT
6	6	FAILURE	HINGE PLATES AT WAIST HARNESS	WEAKENING OF POP RIVETS DUE TO KNOCKS AND ABRASION
7	2	FAULT	SENSOR WIRING	NK

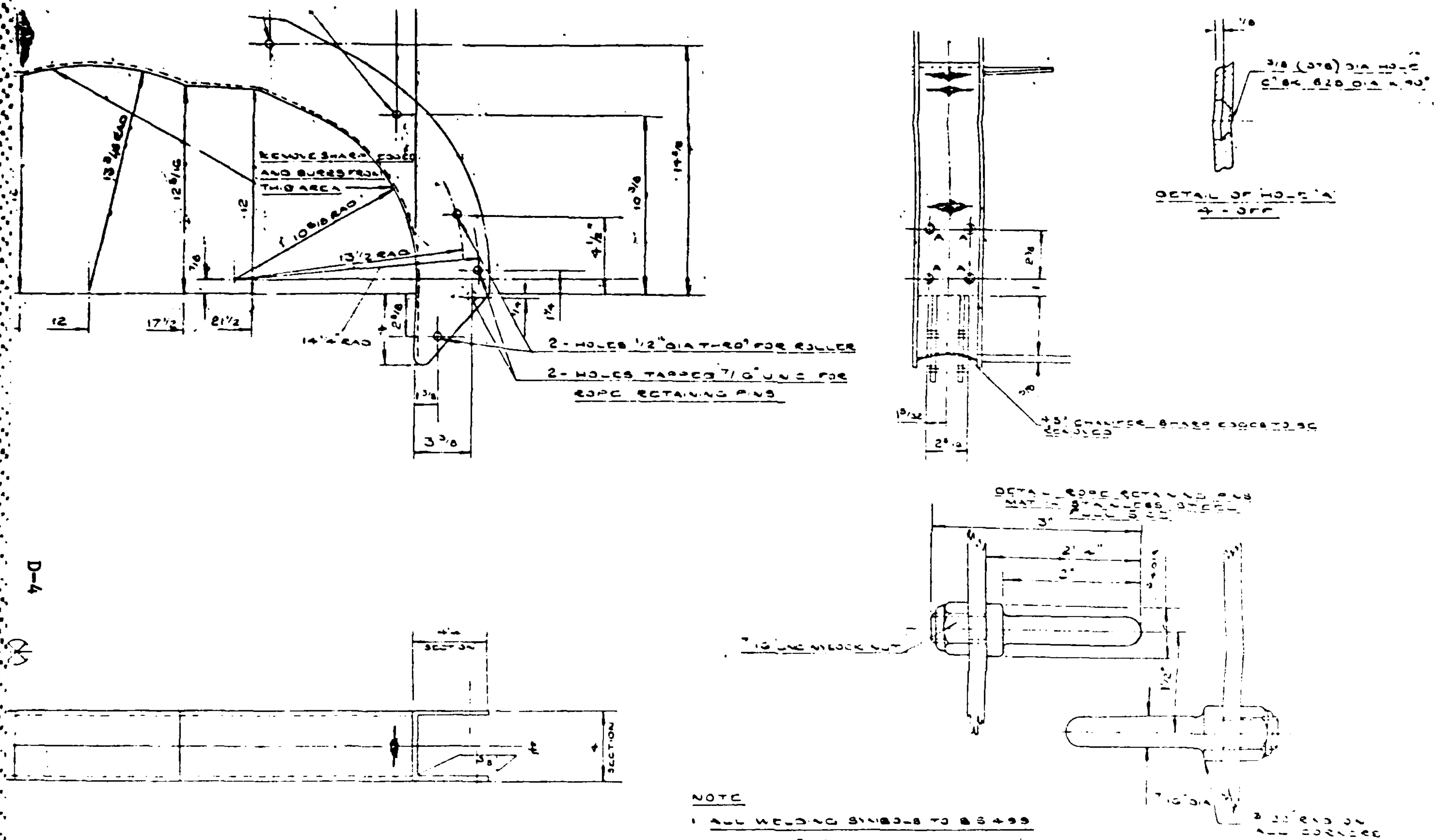
APPENDIX D

TECHNICAL DRAWINGS FOR BOW ROLLER FAIRLEAD



4-HOLES 1/2" (.50) DIA THRU
FOR ROLLERS
4-HOLES 7/16 (.437) DIA THRU
SECURING HOLES IN BASE
OF HAND WINCH





NOTE

1 ALL WELDING SYMBOLS TO BS 499

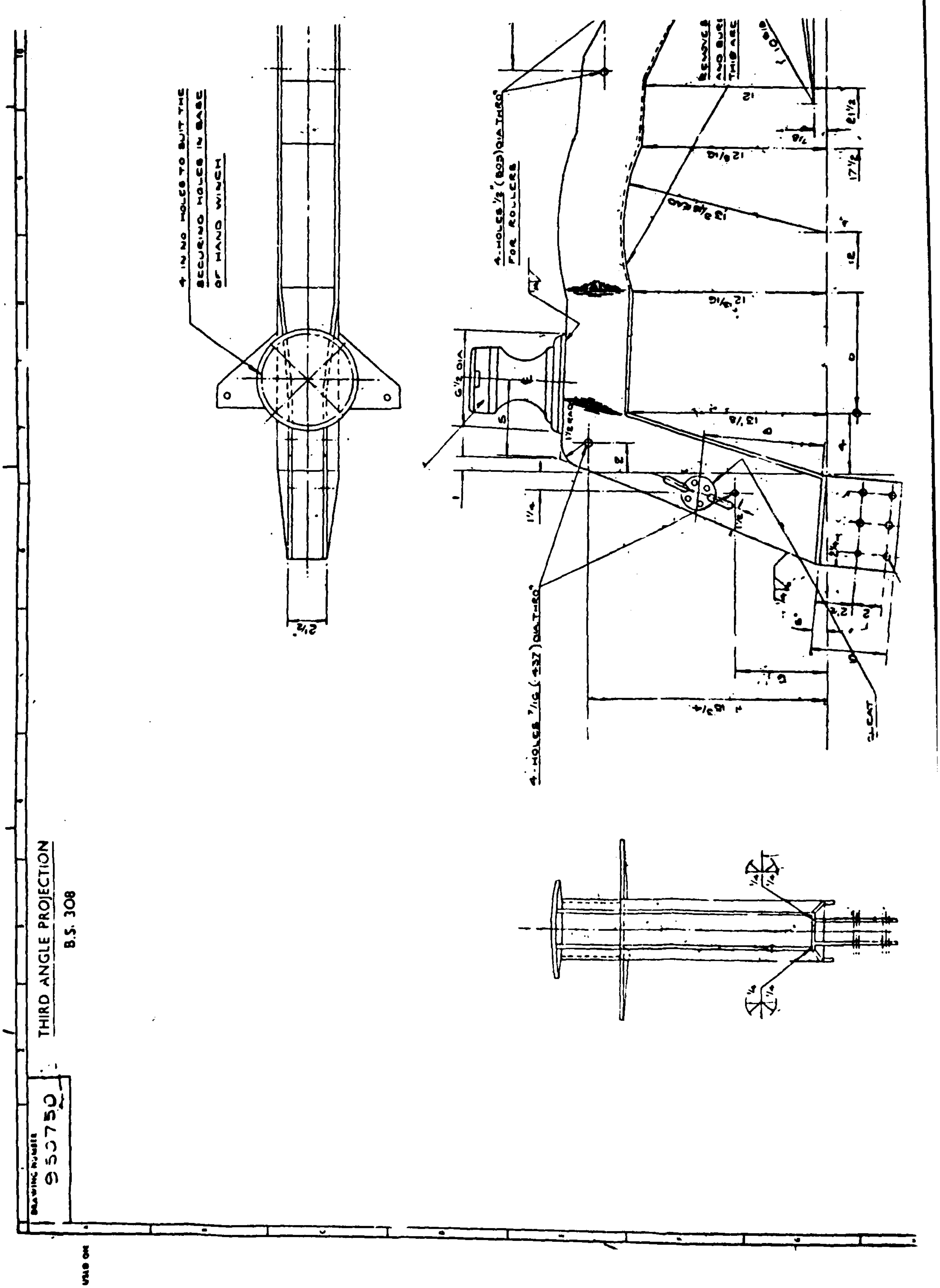
2 3 IN No 3/8" DIAM ALLOY BOLTS 2" LONG C/W NUTS ARE TO BE PROVIDED FOR SECURING FAIRLEAD TO KEEL

3 3 IN No 3/8" DIAM ALLOY BOLTS 1 1/2" LONG C/W NUTS ARE TO BE PROVIDED FOR SECURING FAIRLEAD TO BOW SUPPORT BOARD

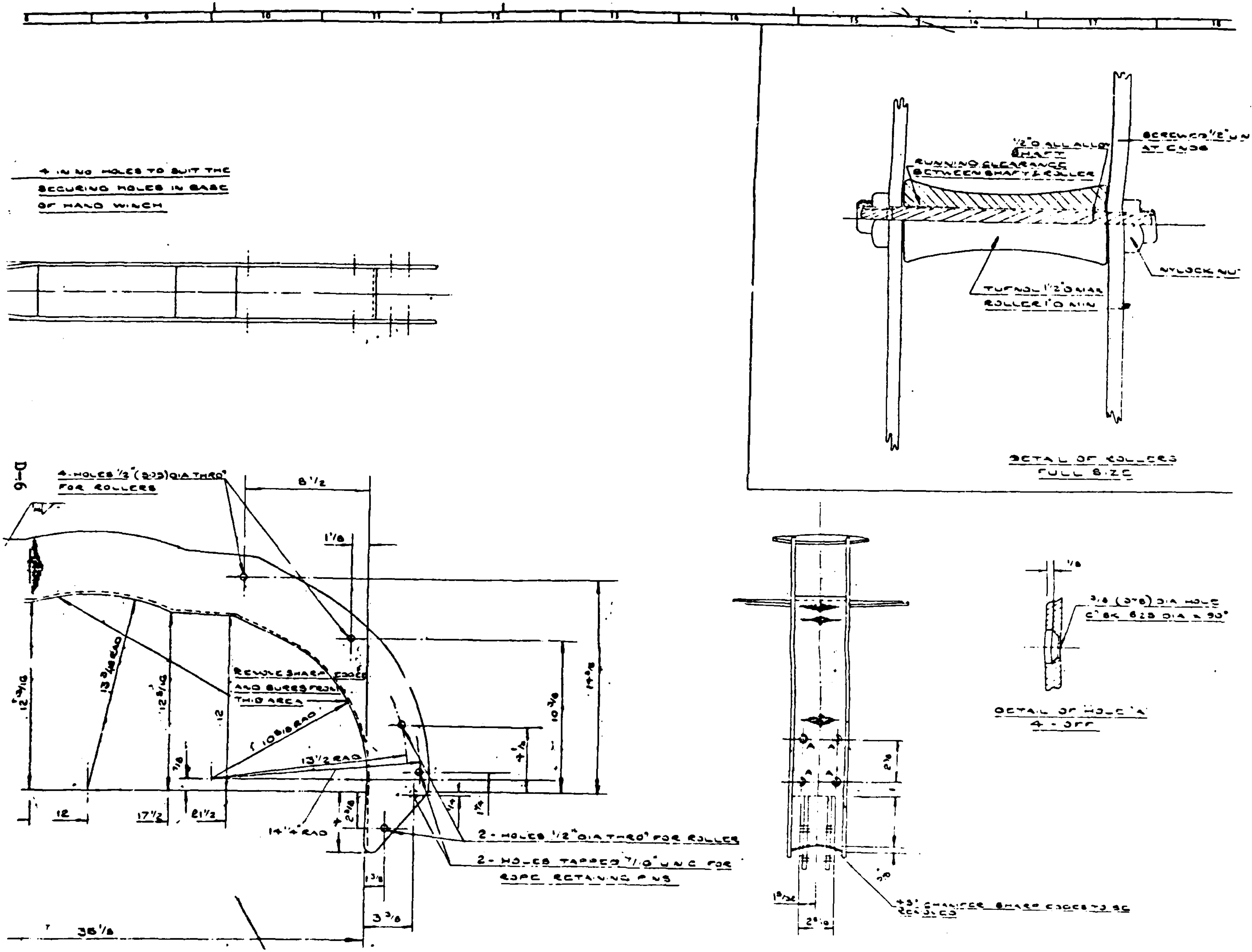
4 BOLTS & NUTS TO BE TO BS 1473 NB-6

MATERIAL	PROTECTIVE FINISH	TOLERANCES	CONTRACTOR	CERTIFIED
		DIMENSIONS IN INCHES	TITLE	CONTRACTOR'S DRAWING REF
		SURFACE ROUGHNESS		DRAWING NUMBER

	ISSUE	DATE



THIRD ANGLE PROJECTION
B.S. 308
4 IN NO HOLES TO SUIT THE SECURING HOLES IN BASE OF HAND WINCH
4 HOLES 1/2" (.505) DIA THRO' FOR ROLLERS
4 HOLES 7/16 (.437) DIA THRO'
6 1/2 DIA


4 IN NO HOLES TO SUIT THE
SECURING HOLES IN BASE
OF HAND WINCH
1/2" DIA ALL ALLOY SHAFT
RUNNING CLEARANCE BETWEEN SHAFT & ROLLER
SCREWED 1/2" UN AT ENDS
NYLOCK NUT
DETAIL OF ROLLERS
FULL SIZE
4-HOLES 1/2" DIA THRO' FOR ROLLERS
REMOVE SHARP EDGES AND BURRS FROM THIS AREA
13 1/2 RAD
14 1/4" RAD
2 - HOLES 1/2" DIA THRO' FOR ROLLER
2 - HOLES TAPPED 7/16" UNC FOR ROPE RETAINING PINS
DETAIL OF HOLE 'A'
4 - OFF
45° CHAMFER SHARP EDGES TO BE REMOVED
8 1/2
12
17 1/2
21 1/2
35 1/8
3 3/8

END

FILMED

DTIC